DOCUMENT RESUME

ED 021 755 SE 004 949

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SCHOOL MATHEMATICS STUDY GROUP REPORT NO. 5, THE SLOW LEARNER PROJECT: THE SECONDARY SCHOOL "SLOW LEARNER" IN MATHEMATICS.
Stanford Univ., Calif. School Mathematics Study Group.
Spons Agency- National Science Foundation, Washington, D.C.
Pub Date 67
Note- 168p.
EDRS Price MF-$0.75 HC-$6.80
Descriptors- ALGEBRA, ARITHMETIC, COMPARATIVE ANALYSIS, *CURRICULUM, CURRICULUM DEVELOPMENT, *INSTRUCTION, LEARNING, LEARNING PROCESSES, *MATHEMATICS, *SECONDARY SCHOOL MATHEMATICS, *SLOW LEARNERS
Identifiers- National Science Foundation, School Mathematics Study Group

Investigated was the mathematics achievement of several hundred junior high school students, believed by their counselors and teachers to be "slow learners." This investigation focused on two critical problems: (1) whether some children benefit from less rapid pacing of material, and (2) which are the strongest predictors of achievement in junior high school mathematics for those labelled "slow learners." It was anticipated that the group of slow learners, 25th to 50th percentile band, would be able to complete in two years material which would be approximately equivalent to the mathematics studied by the control group in one year. The seventh grade youngsters studied the School Mathematics Study Group "Introduction to Secondary School Mathematics" and the ninth grade studied the School Mathematics Study Group "Introduction to Algebra." The resulting statistics of the present study have indicated if the school's classification of the "slow learner" is used, these students show a greater gain in achievement in the "new" mathematics, when a "modified modern" text is studied, and when the pace of instruction is less rapid. (RP)

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SCHOOL
MATHEMATICS
STUDY GROUP

SMSG REPORTS

No. 5

The Slow Learner Project:

The Secondary School "Slow Learner" in Mathematics

Sarah T. Herriot

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Financial support for the School Mathematics Study Group has been provided by the National Science Foundation.

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PART I ANALYSIS

CHAPTER 1

THE PROBLEM

1.1 Curriculum Revision

During the last decade the secondary school mathematics curriculum has been subject to critical scrutiny and has undergone a gigantic upheaval. The prime movers of this curriculum revision questioned the rationale of the consumer utilitarian philosophy with its major emphasis on repetitive drills and acquisition of skills. The speed with which "the new math" won a place in school curricula offerings was startling, even to the most dedicated proponents of a new approach to mathematics. The advent of an era of reform was hailed so quickly by sufficiently diverse and numerous groups of mathematicians in industry, research and teaching that it was evident that some reform was obviously long overdue. The time was ripe for a change.

Through the efforts of the School Mathematics Study Group and other curriculum projects, the secondary school mathematics offerings have been modified or dramatically altered in these recent years. The initial emphasis on the quality of the mathematics diet of the college-bound student, and the lack of recommendations and pilot studies for the average and below-average students, do not necessarily indicate absence of concern about this large group, but reflect only the university mathematician's genuine interest in and intimate knowledge about the college-bound group. The Commission on Mathematics of the College Entrance Examination Board stated:[1]

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[1] College Entrance Examination Board, Report of the Commission on Mathematics, Program for College Preparatory Mathematics (New York: CEEB, 1959), pp. 10-11.

> . . . The Commission realizes that secondary schools must serve the needs of those students who are not bound for college. Many aspects of the Commission's program can be adapted, though this adaptation is a task that the Commission must perforce leave to other hands. . . .

1.2 The "Slow-Learner"

It is generally agreed by all who give school education serious thought that each child deserves the best that he is capable of learning, but there is no consensus as to the precise curriculum of the secondary school satisfying this ideal criterion.

Some "action research," or classroom research, with the neglected non-achievers is essential before educational research can help classroom teachers, most of whom are faced with problems which are virtually non-existent in short-term laboratory-type experiments. These "slow-learners," with years of extremely limited success in school, are required to study mathematics until they are fourteen years old or more. Plagued as it is with diverse problems, this group is not attractive to researchers. "Action research" with this enormous body of students, while not lending itself to a neat, clearly defined study, is necessary as a beginning step.

Research with talented youngsters in a classroom situation presents less problems and is fruitful enough to attract many researchers. There exist, in contrast, strong prejudices and pre-conceived theories among school administrators and teachers about the inability of the "slow-learner" to understand mathematics. This is evidenced by the fact that, historically, manipulation of computational algorithms has been almost their sole bill of fare. The children "who cannot learn mathematics" and meet constant frustration and failure continue to practice manipulative skills until they are finally permitted to discontinue mathematics or until they drop out of school.

The term "slow-learner" is often a misnomer, for scores derived from aptitude, reading and achievement tests are often not uniformly below average. Even if all scores are low, there is a possibility that a low reading level affected the other scores. Attitudes toward the discipline of mathematics, the teacher, the school and education itself may affect the actual achievement. More than most school subjects, mathematics, essentially a sequentially ordered curriculum, is taught in a building-block fashion, and this continuity, inherent in the discipline, is severed by irregular attendance and poor work habits.

This study investigated the achievement of several hundred junior high school students, *believed by their counselors and teachers to be "slow-learners*." Though some studies indicate the depth of the emotional problems of the adolescents as being tied in closely with educational problems, these variables, as predictors, are out of the scope of this research.

CHAPTER 2

NEED FOR A STUDY

2.1 The Drop-outs

The primary problem in beginning basic research on the "slow-learner" is defining just what is meant by the term. Administrators and teachers are often cognizant of the divergent range of students in "slow" classes, but, unfortunately, do little about it, either because of inertia or ignorance of the possible long-term consequences of this festering problem, or more likely because they feel helpless in the face of mounting numbers of adolescents, many of them barely literate, and, more often than not, apathetic and unmotivated.

In this country where public school education is so easily available, and where there is widespread emphasis on high school graduation, forty percent of all children fail to complete high school and become dropouts. Even more alarming are such estimates that approximately forty percent of the students who entered fifth grade in 1963 will never complete their high school education. All this is frightening, for as automation reaches into more and more offices and factories, the trend toward fewer jobs for the unskilled and more unfilled jobs requiring higher education is accelerated.[2]

2.2 Recent Conference

At the April, 1964, School Mathematic Study Group Conference on Mathematics Education for Below Average Achievers, it was quite evident that this pressing problem is of giant proportions and the "experts" do not have the answers.

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[2] See Goodwin Watson, Ed., No Room at the Bottom. Automation and the Reluctant Learner, (Washington: NEA, 1963); and S. O. Lichter, et al., The Drop-Outs (N.Y.: Free Press of Glencoe (Div. of MacMillan Co.), 1962).

Dr. E. G. Begle, Director of SMSG, in his statement of purpose of the Conference, noted:

> In the past decade an enormous amount of work has been done to improve the mathematical programs for the schools in this country . . . From the very beginning SMSG recognized perfectly well that we were doing something for only part of the school population. We have made a remarkable amount of progress, but we are now far enough along to realize that the rest of the school population, the students who are not doing well in mathematics, must be given attention. Once we recognized that it was time to face up to this problem, it did not take long to see that we have a whole spectrum of problems . . .

In the report of the conference Harry Beilin and Lassar G. Gotkin in their paper on "Psychological Issues in the Development of Mathematics Curricula for Socially Disadvantaged Children," raised several critical points, indicating the need for research:

> There are limitations upon when and how children can learn. Our task is to discover what these limitations are. The danger is in calling a halt too soon to efforts to discover what is possible . . . .
>
> According to the 'redundancy' view, a greater encounter with the learning materials is required for slow learners to acquire a concept . . . There is a danger, however, in merely repeating the same materials ad nauseum . . . It is the danger of boredom and frustration for both the pupil and teacher . . . .
>
> There have been two philosophies of mathematics instruction which have divided practitioners in their work with children . . . [1] the attainment of mathematical principles through varied experience . . . [2] providing the learner with a logical structure which he may apply to a variety of physical elements and relations . . . At this stage in our knowledge of mathematical learning it is not possible to adjudicate the differences between these views . . . .

Beilin and Gotkin also cited a number of curriculum policies already accepted in every instance without adequate thought or experimentation as means of reducing school drop-outs: (1) elimination of practice of failing, (2) meeting individual differences,

(3) rejection of homogeneous grouping, (4) elimination of tracking systems, (5) refusal to accept logically arranged materials, and (6) a rejection of grade organization.

Appearing also in this Conference Report is Gloria F. Leiderman's article, "Mental Development and Learning of Mathematics in Slow-Learning Children," in which she critiques the uses and misuses of the I.Q. Her suggestions of possible studies include research in the areas of cognitive and perceptual styles [of disadvantaged children], and research which would isolate and define the necessary and sufficient conditions for the development of symbolic, abstract learning.

CHAPTER 3

RELEVANT RESEARCH

3.1 Availability

Finding abundant and meaningful research on the extremes of the ability spectrum is a relatively simple matter compared to uncovering significant research on the large group of children who achieve below grade level, but are not sufficiently retarded to be placed in special classes.

Much so-called educational research is purely descriptive. Articles of the "advice from the firing lines" variety are often written by teachers who, having experienced some measure of success with a particular slow-learning group, offer their helpful hints to the many teachers searching for new techniques to reach children in similar situations. Other articles are prescriptive, hopefully inspiring teachers to motivate these youngsters to learn. Due to missing data and lack of controls, any general conclusions drawn are somewhat dubious.

Only a handful of articles approach the area of curriculum for the slow learner in any but a fragmented fashion. Seldom has a special curriculum been created specifically for those who cannot produce at "grade level." A mathematics program must be planned specifically for the slow learners, who, without the necessary skills, will be hampered in our complex society.

3.2 Brief Sampling

This ever-present problem of the appropriate and optimum education of the adolescent non-achiever encompasses the fringes of many areas of research. The discussion which follows is of course quite incomplete because of the necessity for brevity and because of the unavoidable broad coverage, but it is indicative of the large body of information that is relevant, through extensions and cautious analogy, to this present study.

A considerable amount of literature is devoted to the construction of tests of mathematical aptitude, and researchers have examined the usefulness of certain aptitude tests as predictors of proficiency in mathematics. For example, the SCHOOL AND COLLEGE ABILITY TEST was developed as a measure of the student's ability to succeed in future academic work, and studies have shown the Quantitative score of SCAT to be highly related to school success in mathematics. The mentally retarded are not as adept in problems involving discrimination and the ability to see relationships. Studies indicate a connection between concept formation and reading.

Mathematics has its own peculiar reading problem. Reading speed does not correlate highly with mathematics success, but reading comprehension does seem to have bearing on mathematics achievement. Research findings stress the importance of special skills in reading mathematical material. It is essential that symbolism, the language of mathematics, be acquired and understood by children. Studies illuminate the low relationship between reading ability and arithmetic achievement but a closer relationship between specific vocabulary and the particular reading skills important in solving verbal problems. Though, with specific training, students have improved in specific skills needed in the reading problems, teachers still maintain vigorously that the reading dilemma continues to be a major obstacle in teaching mathematics to countless under-achievers.

What content the curriculum should encompass is controversial. There is precious little research to point the way. Jerome Bruner in advancing his now well-known and bold hypothesis, "any subject can be taught effectively in some intellectually honest form to any child," reiterates that "no evidence exists to contradict it; considerable evidence is being amassed that supports it."[3] Evident in current articles are the contradictory aspects of the choice of curriculum content. The emphasis in numerous articles is on desirable teacher personal characteristics and teaching techniques successful with the slow learner (a level which few make an attempt to define). The view of the nature of the mathematics to be learned by these students is often strongly biased toward the more traditional content. Appearing in increasing numbers are contrasting articles which plea not to reserve the new mathematics just for the gifted. According to some authors, the "slow", try as they may, usually have to be told. Others believe that even the dullest child can be intrigued by mathematics in which there is an opportunity to discover. A survey of the diverse articles absorbed with the possible content within reach of the "slow-learners" reveals that assignment of an absolute level of difficulty to any particular topic should be done with extreme caution.

Analyses of children's interests serve as a sharp reminder that their interests are not always what adults envision them to be. The interest level of children is one vital criterion in three phases of the curriculum: what, when and how to reach. Research conclusions, (e. g.: Interest can be stimulated in the slow-learning child. The level of skills can be raised by careful selection of materials.), have far-reaching implications, but investigation shows a dearth of materials for the slow-learning child. Motivation is now seen as coming from within the learner, instead of being viewed merely as a classroom device to arouse pupil interest. A review of both educational and psychological literature reveals little work attempted in measurement of internal motivational systems with regard to school work, despite the importance of motivation to effective teaching.

---

[3] J. S. Bruner, The Process of Education (New York: Random House, 1960, or Vintage Books, 1963), p. 33.

The image our culture has of the dull and the smart is a common definition of the "slow-learner": Speed is rewarded, since the "fast" child is considered smart, and the "slow" one dull. This is considered basically false by those who propound vigorously the weaknesses in speed and the strengths in slowness.

Though most of the research has dealt with "traditional" topics, some recent research has been undertaken to see if "modern" mathematics could be taught effectively with slow learners. The few available studies are too often, unfortunately, not well enough controlled to ascertain the reasons for apparent success in some respects and lack of success in others. It can be concluded from these that there were many unanswered questions, and further research was needed. These studies, however, contribute to an area in which there are just the bare beginnings of research.

In SMSG investigations of the results of their sample school texts, the focus has been on curricular research; i.e., the relationship between the subject matter taught and the resulting student behavior. The "methods" variable has been randomized. (Most attempts at studies comparing teaching methods lack sophistication and are insignificant scientifically. While present evidence does not yet demonstrate that teachers' understanding of pupils makes any difference, it does seem self-evident that this trait is desirable in people involved in teaching since human interaction predominates in teacher-pupil relationships. Research has yet to reveal the specific features of teacher personality which are distinctive enough to identify the effective teacher.

Another key problem area about which little is known is what learning experiences produce changes in the affective as well as in the cognitive domain. Our present attacks on this vast domain are, as yet, rather feeble. There is absence of theory and evidence to guide research efforts. The affective domain is, for this reason, out of the scope of this research.

CHAPTER 4

PURPOSE OF STUDY

4.1 Focal Points

In this exploratory study, several controversial areas were probed in an attempt to give some direction for future research. Junior high school students tagged as "slow-learners" rarely get an opportunity, even now, to be taught the "new math" and the studies in the past have, of course, been concentrated in the traditional curriculum. This investigation, in formally examining the achievement of seventh and ninth grade "slow-learners" studying mathematics with a more "modern" emphasis, focalizes on two critical issues:

1. TIME. Do some children benefit from less rapid pacing of the material? A dichotemy of opinions exists, and earlier studies reveal no satisfactory answers. Many educators feel that some children learn slowly and if given sufficient time are capable of learning much more than they do now; others, not sharing this optimism, feel that the abstractions of mathematics are too difficult for some children, no matter what time is allotted.

2. PREDICTORS. What are the strongest predictors of achievement in junior high school mathematics for those labelled as "slow-learners?" Do initial tests of ability, reading, and mathematical achievement play a major role in prediction of success in the "new math" for these students?

4.2 Principal Aims

The direction of this study was implied tangentially in the preceding pages, but the following summary statement provides further clarification:

The principal aims of this research were:

(1) to generate and test hypotheses by statistical analysis of the "slow-learner" study, and

(2) to suggest research areas for further study by inference from the statistical analysis of the present study, available anecdotal information from the present study, and related research from earlier studies.

CHAPTER 5

POPULATION

5.1 Experimental

In the fall of 1963, several coordinators, representing school districts in different geographical sections of the country and expressing interest in participating in a study of the slower students at the junior high school level, selected seventh and ninth grade children with abilities in the 25th to 50th percentile band for a study.

Dr. E. G. Begle, Director of SMSG, in his instructions to the coordinators, stated that the purpose of the study was to investigate the learning of modern mathematics by students who were below average in ability but were to be permitted to proceed at a slower pace. It was anticipated that this group of slow learners designated by the local coordinators would complete in two years material which would be roughly equivalent to the mathematics studied by the other children in one year. The seventh grade youngsters studied the SMSG *Introduction to Secondary School Mathematics*; the ninth grade, the SMSG *Introduction to Algebra*. For a more detailed explanation about these particular texts see the Appendix B(I).

5.2 Control

In the fall of 1964, seventh and ninth graders with abilities in the fiftieth to seventh-fifth percentile range were selected by local coordinators to study in one year the two-year program of the experimental group. These students studied the same texts and were subjected to the same testing program given to the experimental classes. This one-year group acted as a control group.

CHAPTER 6

TESTING PROGRAM

6.1 Initial

At the beginning of the school year the following tests were administered to the students:

7th grade: SRA, Form A; SCAT, Form 4A; Davis, Form 2A.

9th grade: COOP Arithmetic, Form A; SCAT, Form 3A, Davis, Form 2D.

SRA had 3 scores: reasoning, concepts, computation; COOP, 1 score; SCAT, 2 scores: verbal, quantitative; Davis, 2 scores: level of comprehension, level of speed. (SRA and COOP measure mathematics achievement; SCAT, ability; and Davis, reading.) See Appendix B(II) for additional details on standardized tests.

6.2 Intermediate

The initial battery designed to measure ability, achievement and reading level was followed during the school year(s) by achievement tests. Tests and corresponding Teachers' Commentaries were supplied and the SMSG achievement tests were based on these tests. The "block tests" each of 35 multiple-choice items, covered two, three, or sometimes four chapters. There were eight "block tests" in arithmetic; eight, in algebra. Participating teachers administered these to their students and returned the results to SMSG. See Appendix B(III) for additional details on "block tests".

6.3 Final

At the end of the program the following tests were administered to the students:

7th grade: COOP Arithmetic, Form A; SMSG Arithmetic Achievement Test based on text.

9th grade: COOP Algebra, Form B; SMSG Algebra Achievement Test based on text.

In addition, the teachers were requested to answer the questions on the Minnesota Teacher Attitude Inventory and to administer to their students a questionnaire. See Appendices B(IV) and B(VII) for details.

CHAPTER 7

VARIABLES

7.1 Predictor

Scores of the initial battery were chosen as predictor variables for the groups indicated:

	7th grade (ARITH)	9th grade (ALG)
Ability:	SCAT Q	SCAT Q
	SCAT V	SCAT V
Reading:	DAV S	DAV S
	DAV L	DAV L
Math. Achievement:	SRA REAS	COOP ARITH
	SRA CONC	
	SRA COMP	

See Appendix B(II) for details on standardized tests.

7.2 Criterion

The final achievement tests served as criterion variables for the groups indicated:

	7th grade (ARITH)	9th grade (ALG)
Math. Achievement:	COOP ARITH	COOP ALG
	SMSG ARITH	SMSG ALG

See Appendix B(II) for details on standardized COOP tests; B(IX), final SMSG achievement tests; B(I), details on texts on which these SMSG achievement tests were based.

7.3 Criterion Sub-scales

In order to investigate some of the skills and concepts studied by the students, content scales were developed from the final SMSG achievement tests. In Appendix A the tables of the complete statistical analysis include these content scales as criterion variables. Because of inconclusive results, however, the sub-scales will be discussed only in Chapter 12, as possible inferences for further research. In Appendix B(V) are found the Cronbach Alphas of the SMSG tests and of all sub-scales.

The scales chosen were as follows:

SON (systems of numbers)	SMSG final test on *Introduction to Secondary School Mathematics*
FDP (fractions, decimals, percentage)	
GEO (geometry)	
REA (reading)	
TSB (test subscale - 4 abstract items deleted)	
E &I (equations & inequalities)	SMSG final test on *Introduction to Algebra*
INE (inequalities)	
AEX (algebraic expressions)	
FSP (factoring, special products)	
ASP (application: structure, properties)	
COO (coordinates)	
REA (reading)	
TSB (test subscale - 4 abstract items deleted)	

CHAPTER 8

POPULATION DIVISION

8.1 Method

Owing to the exploratory nature of this study, one half of the data was used for "data-snooping" to generate hypotheses; the other half served to test the hypotheses generated by this investigation. In order to make a statistical analysis of the data, it was necessary to consider only those students for whom complete data was available. The division of the data deck into two parts was achieved by a random number generator program.

8.2 Sub-sets

For ease of reference, various subsets of the population will be given meaningful symbolic representation: two letters followed by a single digit. A brief interpretation follows:

First letter is either
  S: 7th grade (arithmetic), or
  A: 9th grade (algebra).
Second letter is either
  E: experimental group (2-year study), or
  C: control group (1-year study).
Single digit is either
  1: hypotheses-generating half, or
  2: hypotheses-testing half.

To clarity further these designations, which will be used throughout this report, another arrangement follows:

1.	hypotheses-generating half	(Analysis in Chapter 9)	
SE1	arithmetic - experimental	(2-year study)	N = 122
SC1	arithmetic - control	(1-year study)	N = 172
AE1	algebra - experimental	(2-year study)	N = 89
AC1	algebra - control	(1-year study)	N = 109
2.	hypotheses-testing half	(Analysis in Chapter 10)	
SE2	arithmetic - experimental	(2-year study)	N = 140
SC2	arithmetic - control	(1-year study)	N = 187
AE2	algebra - experimental	(2-year study)	N = 95
AC2	algebra - control	(1-year study)	N = 106

PART II RESULTS

CHAPTER 9

HYPOTHESES GENERATED

9.1 Introduction

9.11 Procedure. For the hypotheses-generating phase of the research, an analysis of the data of 294 seventh graders (122 in experimental group, and 172 in control group), and 198 ninth graders (89 in experimental group, and 109 in the control group) was carried out by the following statistical procedures:

(1) Intercorrelations were computed as a measure of the degree of relationship among the variables.

(2) The prediction of any one of the dependent variables on the basis of the independent variables was investigated by means of regression equations.

(3) Homogeneity of regression was tested.

(4) Significance of the differences between the predictor variable means of the experimental and control groups was ascertained.

(5) Significance of the differences between the criterion variable means and adjusted means of the experimental and control groups was investigated.

9.12 Null Hypotheses Rationale. For the purpose of hypotheses-testing in Chapter 10 positive conjectures derived from the hypotheses-generating data will be proposed as NULL HYPOTHESES. It may seem somewhat devious to propose and to test these alternate statements, but proposing a null hypothesis and either accepting or rejecting it at certain probability levels can be tested, and we have no statistical model to represent the positive statement. "If the null hypothesis is true, we can predict what would happen statistically; there is no way of predicting accurately what would happen if the alternate hypothesis were true. When the null hypothesis is not true, there is a host of other possibilities, each of which has to be tested in turn. The null hypothesis can be stated mathematically as a particular, well-defined, testable case."[4]

9.2 Results

9.21 Intercorrelations. Initial measures of quantitative ability and mathematics achievement are more highly related to the final criterion than verbal and reading scores. These correlations, which anticipate the results of the regression equations, appear in Appendix A(Ic, Id, IIIc, IIId).

9.22 Regression Equations. Detailed tables of regression equations, multiple correlation coefficients, and analysis of covariance appear in Appendix A(If, IIIf), but a brief summary table here focuses on important results.

ANALYSIS OF COVARIANCE

SIGNIFICANCE OF REGRESSION EQUATIONS IN PREDICTION OF DEPENDENT VARIABLES.

SC1 - SE1 DEP VAR	df = (7,278) F	AC1 - AE1 DEP VAR	df = (5,186) F
COOP	96.9^{***}	COOP	26.3^{***}
SMSG	45.5^{***}	SMSG	17.6^{***}

*Significant at .001 level. ($p < .001$)

The large F values above indicate that the regression equations as predictors of COOP and SMSG tests of seventh and ninth graders are significant at the .001 level; that is, the probability that this result is due to random sampling errors is .001.

---

[4] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw Hill, 1965), p. 173.

The following hypothesis, to be tested in Chapter 10, is formulated, as a result of the above analysis:

NULL HYPOTHESIS: REGRESSION EQUATIONS AS PREDICTORS OF THE CRITERION VARIABLES ARE NOT SIGNIFICANT.

The accuracy with which the regression coefficients, or weights, predict the values of the criterion variables is determined by the multiple correlation coefficient, R. (Definition of multiple correlation coefficient: the correlation between z_1 and the best estimate of z_1 from a knowledge of z_2 and z_3.) The RSQ (R squared) column indicates that if causation can be assumed, the multiple R squared indicates the percent of variance in the criterion variable that can be attributed to specified independent variables.

In this regression analysis the order in which the independent variables were entered was not specified, and it is no surprise that measures of quantitative ability and mathematics achievement accounted for most of the variance attributable to the independent variables, because of the high correlations of these predictor variables and the criterion variables. This is indicated in Appendix A (If, IIIf) but a brief summary follows:

INDEPENDENT VARIABLES AS PREDICTORS OF DEPENDENT VARIABLES

SC1 (N = 172) APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:			SE1 (N = 122) APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:	
ALL IND VAR	BEST PRE-DICTOR	DEP VAR	ALL IND VAR	BEST PRE-DICTOR
75	63 (SCAT Q)	COOP A	57	45 (SCAT Q)
66	59 (SCAT Q)	SMSG	40	28 (SRA CONC)

AC1 (N = 109) APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:			AE1 (N = 89) APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:	
ALL IND VAR	BEST PRE-DICTOR	DEP VAR	ALL IND VAR	BEST PRE-DICTOR
61	54 (COOP A)	COOP B	24	22 (COOP A)
44	38 (COOP A)	SMSG	29	25 (SCAT Q)

If Reading scores were forced in first, the amount of contribution would be less, but would still seem relatively high. The independent measures overlap in their predictive values. When the strongest one has been selected, the others have little to add that the strongest one has not already included.

RSQ is easily computed for any variable entered first by squaring the correlation coefficient. Additional entries cannot, of course, be computed in this way. The total variance contributed by the independent variables remains the same no matter which one is forced in first.

When two or more independent variables are measured, it is generally appropriate to calculate a regression equation, including such variables as contribute significantly to the relationship, but we also need to compare the efficiency of the predictors. In regression analysis, the value often lies not so much in enabling one variable to be predicted from others as in assessing the magnitude of the effects of one or factors and in separating out the relative contribution of each. Since they involve different units of measure, the coefficients of the raw score regression equations cannot be interpreted as indicating the relative contribution of each independent variable, but from the ratio of the beta coefficients, the relative power of the independent variables as predictors of the dependent variables can be estimated. In order to assess the importance of Reading this procedure was followed. As a conservative statement SCAT Q has at least double the weight of Reading in all regression equations, and, contrary to what might have been predicted, Reading appears to have less weight (in comparison to quantitative or achievement scores) in prediction of the SMSG tests than it does in prediction of the COOP tests. SCAT V is no more powerful than Reading as a predictor, and in the prediction of algebra final scores, its contribution is negligible.

9.23 Homogeneity of Regression. From the small F values obtained in the tests of homogeneity of regression of the criterion variables on the predictor variables, it is clear that for the hypothesis-generation phase heterogeneity of regression is rejected. Detailed tables are in Appendix A (If, IIIf). A summary table follows:

TEST OF HOMOGENEITY OF REGRESSION ON THE PREDICTOR VARIABLES BY THE CRITERION VARIABLES:

SC1 - SE1	df = (7,278)	AC1 - AE1	df = (5,186)
CRITERION VARIABLES	F	CRITERION VARIABLES	F
COOP ARITH	.346 #	COOP ALG	.608 #
SMSG ARITH	.339 #	SMSG ALG	.220 #

# Not Significant

The following null hypothesis is, therefore, proposed:

NULL HYPOTHESIS: HETEROGENEITY OF REGRESSION OF THE CRITERION VARIABLES ON THE PREDICTOR VARIABLES IS INDICATED AT A SIGNIFICANT LEVEL.

9.24 Differences of Predictor Means. Students in the 2-year experimental programs were selected because they were considered "slow-learners" particularly in their below-average performance in mathematics. On the other hand, students comprising the control group were designated as above-average in their school mathematics. Therefore, it is reasonable to believe that these groups initially differed, but it is necessary to test that they differed significantly. The tables show that the means differ, and a univariate analysis of variance indicates that on initial testing they differed significantly, since the variance ratio, or F, is larger than expected on basis of chance. Detailed tables of the means are found in Appendix A (Ib, IIIb); the univariate analysis of variance, Appendix A (Ie, IIIe). A brief summary table follows:

PREDICTOR VARIABLES:

MEANS, AND SIGNIFICANCE OF DIFFERENCES OF MEANS

ARITH GROUPS

IND VAR	SC1		SE1		Sig. of difference F (1,292)
	MEAN	S.D.	MEAN	S.D.	
SCAT Q	31.7	9.8	24.4	7.4	48.15^{***}
SCAT V	42.8	10.5	32.5	10.3	70.18^{***}
DAV S	28.4	15.7	13.7	11.3	78.80^{***}
DAV L	18.3	8.1	10.0	7.6	70.07^{***}
SRA RE	21.3	7.3	16.9	6.4	28.70^{***}
SRA CC	17.2	4.9	13.2	4.2	51.72^{***}
SRA CP	22.7	8.1	18.2	6.5	25.55^{***}

*Significant at .001 level. ($p < .001$)

ALG GROUPS

IND VAR	AC1		AE1		Sig. of difference F (1,196)
	MEAN	S.D.	MEAN	S.D.	
SCAT Q	30.1	8.2	24.1	5.7	33.51^{***}
SCAT V	36.7	12.0	33.4	7.7	5.12^{+}
DAV S	41.2	18.6	35.4	13.5	3.84^{+}
DAV L	23.9	9.4	20.5	6.8	8.00^{++}
COOP	30.9	8.0	27.2	5.3	13.52^{***}

Significance levels:

$^{***}p < .001$

$^{++}.001 < p < .005$

$^{+}.01 < p < .025$

From the above information is formulated the following:

NULL HYPOTHESIS: THERE IS NO SIGNIFICANT DIFFERENCE IN THE INITIAL SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS.

9.25 Differences of Criterion Means and of Adjusted Means. At the end of the study the two-year "slow-learners" and the one-year above-average (control) groups were given two final achievement tests: the COOP and the SMSG tests based on the texts.

Since the Coop tests have published national norms, it might be informative to look at these in order to visualize actual achievement. The results were as follows:

COOP ARITH (FORM A)	SC1	SE1
RAW MEAN	28.01	23.7
PERCENTILE BAND	54 - 83	41 - 70
MID-PERCENTILE RANK	70	54

COOP ALGEBRA (FORM B)	AC1	AE1
RAW MEAN	21.1	21.0
PERCENTILE BAND	36 - 66	36 - 66
MID-PERCENTILE RANK	48	48

For the statistical analysis of this phase, the criterion raw means were adjusted for initial differences. A brief interpretation of the results of the final tests is as follows:

SC1-SE1. The control group achieved significantly higher than the experimental group (.01 level for COOP; .05, for SMSG), but when scores were adjusted for initial differences, the situation was reversed, i.e., on adjusted scores the experimental group was significantly higher than the control group (.005 level for COOP; .001, for SMSG).

AC1-AE1. There was no significant difference between the achievement of the control and experimental groups, but the experimental group was significantly higher on the adjusted scores (.005 level for COOP; .001, for SMSG).

Detailed tables of means may be found in Appendix A (Ib, IIIb); adjusted means, Appendix A (Ig, IIIg); and significance of difference, Appendix A (If, IVf). The summary table below sufficiently reiterates the above interpretation, by indicating the significance of the differences of the means and of the adjusted means of the criterion tests for the experimental and the control groups:

CRITERION VARIABLES:
MEANS, SIGNIFICANCE OF DIFFERENCE OF MEANS,
ADJUSTED MEANS, SIGNIFICANCE OF DIFFERENCE OF ADJUSTED MEANS.

	MEANS			ADJUSTED MEANS		
VAR	SC1	SE1	z	SC1	SE1	F
COOP A	28.0	23.7	5.5^{**}	25.5	27.3	8.6^{++}
SMSG	17.0	16.2	1.8^{*}	15.3	18.6	42.5^{***}
VAR	AC1	AE1	z	AC1	AE1	F
COOP B	21.1	21.0	0.4#	19.8	22.6	10.3^{++}
SMSG	15.0	16.0	1.0#	13.9	17.3	23.0^{***}

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*Sig. at .05 level
**Sig. at .01 level
***Sig. at .001 level

$^{++}$Sig. at .005 level
#Not significant

From the above investigation can be formulated the following:

NULL HYPOTHESIS: EXPERIMENTAL AND CONTROL GROUPS ARE NOT SIGNIFICANTLY DIFFERENT ON CRITERION VARIABLES AFTER ADJUSTING WITH COVARIATES.

9.3 Summary

In this exploratory phase of the study of experimental and control groups studying specified "modern" curricula of the junior high school, the following results emerged from the statistical analysis of a random half of the data:

(1) Correlation coefficients indicate that the initial measures of quantitative ability and of mathematical achievement are strongly related to criterion measures.

(2) Investigation of regression equations leads to a conjecture, stated here as a null hypothesis:

H_o: REGRESSION EQUATIONS AS PREDICTORS OF THE CRITERION VARIABLES ARE NOT SIGNIFICANT.

In this exploratory stage H_o was rejected at the .001 level; therefore it appears that regression equations with initial tests as covariates are predictive of final test results. Analysis of RSQ and regression coefficients indicated that of the independent variables the strongest predictors of the criterion variables were the initial scores of quantitative ability and of mathematical achievement.

(3) Tests of homogeneity lead to the proposal of a second null hypothesis:

> H_o: HETEROGENEITY OF REGRESSION OF THE CRITERION VARIABLES ON THE PREDICTOR VARIABLES IS INDICATED AT A SIGNIFICANT LEVEL.

The degree of heterogeneity was not significant; i.e., homogeneity of regression for all groups is borne out by the homogeneity test in the analysis of covariance, using the first half of the data.

(4) Comparing mean scores on initial tests led to a conjecture, stated again as a null hypothesis:

> H_o: THERE IS NO SIGNIFICANT DIFFERENCE ON THE INITIAL SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS.

Analysis of the first half of the data indicated a significant difference between mean scores of the experimental and the control groups on initial testing. For the ARITH groups, H_o was rejected at the .001 level; for the ALG groups, H_o was rejected at the .001 level for SCAT Q and COOP ALG, at the .005 level for DAV L, and at the .025 level for DAV S.

(5) Significance tests on final test scores of the first random half of the population leads to a possible conclusion stated here as a null hypothesis:

> H_o: EXPERIMENTAL AND CONTROL GROUPS ARE NOT SIGNIFICANTLY DIFFERENT ON CRITERION VARIABLES AFTER ADJUSTING WITH COVARIATES.

Investigation revealed a significant difference between adjusted mean scores of experimental and control groups on final testing. For the ARITH groups, while the control group was significantly higher (.01 level for COOP and .05 for SMSG) on actual scores, the experimental group was significantly higher (.005 level for COOP, and .001 for SMSG) on adjusted scores. For the ALG group, while their actual scores did not differ significantly, the experimental group was significantly higher on the adjusted scores (.005 level for COOP; .001 for SMSG). Therefore, in the exploratory investigation, H_o, the null hypothesis, was rejected at the .001 level for SMSG tests and at the .005 level for COOP tests.

These conjectures, based on results of an investigation of a random half of the data and proposed as null hypotheses, now must be tested on the other half of the data. This analysis follows in Chapter 10.

CHAPTER 10

HYPOTHESES TESTED

10.1 Introduction

The original data deck was randomly divided, and the first half was utilized for "data-snooping." Hypotheses generated in this way were proposed in the previous chapter, and in this one these hypotheses will be tested by an analysis of the second half of the data.

For this hypotheses-testing phase of the research, an analysis of the data of 327 seventh graders (140 in experimental group, and 187 in control group), and 201 ninth graders (95 in experimental group, and 106 in control group), was carried out by the same statistical procedures outlined in the previous chapter.

10.2 Results

10.21 Intercorrelations. Similar to the results of the first half, intercorrelations of the variables of this group indicate a strong relationship between the initial quantitative and achievement scores, and the final achievement scores. These correlations appear in Appendix A (IIc, IId, IVc, IVd).

10.22 Regression equations. The following null hypothesis was proposed in Chapter 9:

H_o: REGRESSION EQUATIONS AS PREDICTORS OF THE CRITERION VARIABLES ARE NOT SIGNIFICANT.

Detailed tables may be found in Appendix A (IIf, IVf), but a brief summary table of relevant data from the hypothesis-testing half will clarify the discussion.

ANALYSIS OF COVARIANCE

SIGNIFICANCE OF REGRESSION EQUATIONS
IN PREDICTION OF DEPENDENT VARIABLES.

SC2 - SE2	df = (7,311)	AC2 - AE2	df = (5,189)
DEP VAR	F	DEP VAR	F
COOP	108.4***	COOP	28.1***
SMSG	51.9***	SMSG	21.4***

***Significant at .001 level ($p < .001$).

Since the F values are quite large, the NULL HYPOTHESIS: REGRESSION EQUATIONS AS PREDICTORS OF THE CRITERION VARIABLES ARE NOT SIGNIFICANT, is rejected at the .001 level.

In this regression analysis of the second half of the data, the order in which the independent variables were entered was again not specified, and again the measures of quantitative ability and mathematics achievement accounted for most of the variance attributable to the independent variables. This is indicated in the summary table below: (See Appendix A (IIf, IVf) for detailed tables.)

INDEPENDENT VARIABLES AS PREDICTORS OF DEPENDENT VARIABLES

SC2 (N = 187)			SE2 (N = 140)	
APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:			APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:	
ALL IND VAR	BEST PRE-DICTOR	DEP VAR	ALL IND VAR	BEST PRE-DICTOR
74	64 (SCAT Q)	COOP	61	49 (SCAT Q)
61	53 (SCAT Q)	SMSG	45	40 (SCAT Q)

AC2 (N = 106)			AE2 (N = 95)	
APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:			APPROXIMATE PERCENTAGE OF VARIANCE ATTRIBUTABLE TO:	
ALL IND VAR	BEST PRE-DICTOR	DEP VAR	ALL IND VAR	BEST PRE-DICTOR
54	44 (SCAT Q)	COOP	39	31 (SCAT Q)
54	45 (SCAT Q)	SMSG	26	19 (COOI A)

Ratios of the beta coefficients (converted from raw score coefficients) confirmed earlier findings of Chapter 9 that the weight assigned to reading is less than half the weight of quantitative ability or achievement scores, and the contribution of verbal ability is negligible in comparison to the other predictor variables.

10.23 Homogeneity of Regression. The following null hypothesis was proposed in Chapter 9:

> H_o: HETEROGENEITY OF REGRESSION OF THE CRITERION VARIABLES ON THE PREDICTOR VARIABLES IS INDICATED AT A SIGNIFICANT LEVEL.

From the F values obtained in the tests of homogeneity of regression (Appendix A (IIf, IVf)) of the criterion variables on the predictor variables, it is clear that, for this hypotheses-testing phase of the analysis, heterogeneity is rejected, since $p \nless .05$.

A summary table of F values verifies this homogeneity of regression.

TEST OF HOMOGENEITY OF REGRESSION ON THE PREDICTOR VARIABLES BY THE CRITERION VARIABLES

SC2 - SE2	df (7,311)	AC2 - AE2	df (5,189)
CRITERION VARIABLES	F	CRITERION VARIABLES	F
COOP ARITH	$.981^{\alpha}$	COOP ALG	$.788^{\alpha}$
SMSG ARITH	1.869^{β}	SMSG ALG	1.943^{β}

Significance levels: $^{\alpha}\ .25 < p$

$^{\beta}\ .05 < p < .10$

10.24 Differences of Predictor Means. In the first half it was found that the "slow-learners" did differ from the control students on their initial scores; however, F values indicated a less significant difference in the algebra groups than in the arithmetic groups. On this second half the F's remain quite large for the arithmetic groups, but the suspicions aroused on the first half by the significance levels of the differences of the means of the initial scores of the experimental and control algebra groups are now confirmed, in this second half of the data.

Proposed in Chapter 9 and tested now is the null hypothesis:

H_o: THERE IS NO SIGNIFICANT DIFFERENCE IN THE INITIAL SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS.

H_o, the null hypothesis, is rejected at the .001 level for all independent variables of the S (ARITH) groups.

For the algebra groups: H_o is rejected at .025 level ($.01 < p < .025$) for SCAT Q; judgment is withheld for the acceptance or rejection of H_o for DAV L and COOP ARITH ($.05 < p < .10$); H_o is accepted for DAV S ($.10 < p < .25$) and for SCAT V ($p > .25$). A summary table of means (Appendix A (IIb, IVb)) and F values (Appendix A (IIe, IVe)) is self-explanatory.

PREDICTOR VARIABLES:
MEANS, AND SIGNIFICANCE OF DIFFERENCES OF MEANS

ARITH GROUPS

IND VAR	SC2 MEAN	SC2 S.D.	SE2 MEAN	SE2 S.D.	Sig. of difference F (1,325)
SCAT Q	30.3	10.7	23.5	8.3	38.26^{***}
SCAT V	40.9	10.3	32.0	11.4	54.45^{***}
DAV S	26.4	16.0	15.4	12.3	46.00^{***}
DAV L	17.5	9.2	10.6	7.9	50.97^{***}
SRA RE	21.1	7.4	16.6	5.7	34.91^{***}
SRA CC	16.7	5.1	13.6	4.1	35.66^{***}
SRA CP	22.3	8.4	18.2	6.6	23.44^{***}

***Sig. at .001 level ($p < .001$)

ALG GROUPS

IND VAR	AC2 MEAN	AC2 S.D.	AE2 MEAN	AE2 S.D.	Sig. of Difference F (1,199)
SCAT Q	28.8	9.1	26.1	7.1	5.56^{+}
SCAT V	33.6	12.4	34.3	8.3	$.21^{\epsilon}$
DAV S	36.7	18.9	32.9	16.9	2.35^{α}
DAV L	21.8	9.6	19.2	9.6	3.53^{β}
COOP	29.6	7.8	27.9	5.4	3.13^{β}

Significance levels
$^{+}.01 < p < .025$
$^{\beta}.05 < p < .10$
$^{\alpha}.10 < p < .25$
$^{\epsilon}.25 < p$

10.25 Differences of Criterion Means and of Adjusted Means. At the end of the study the students' achievement was evaluated by two final tests: COOP and SMSG. Based on national norms available for the

COOP tests, the results were as follows:

	SC2	SE2
COOP ARITH (FORM A)		
RAW MEAN	27.3	23.5
PERCENTILE BAND	54 - 83	41 - 70
MID-PERCENTILE RANK	70	54
COOP ALGEBRA (FORM B)	AC2	AE2
RAW MEAN	20.5	24.0
PERCENTILE BAND	36 - 66	48 - 79
MID-PERCENTILE RANK	48	66

We need, now, an investigation of the NULL HYPOTHESIS:

H_o: EXPERIMENTAL AND CONTROL GROUPS ARE SIGNIFICANTLY DIFFERENT ON CRITERION VARIABLES AFTER ADJUSTING WITH COVARIATES.

A brief interpretation of the results follows:

SC2-SE2. The results of the first analysis were confirmed. The control group achieved significantly higher than the experimental group (.01 level), but when the scores were adjusted for initial differences, the experimental group was significantly higher than the control group (.005 level for COOP, .001 for SMSG).

AC2-AE2. The experimental group was significantly higher on criterion tests (.01 level) and the difference was even more significant on adjusted scores (.001 level).

Detailed tables of means may be found in Appendix A (IIb, IVb); adjusted means, Appendix A (IIg, IVg); and significance of differences, Appendix A (IIf, IVf). The summary table below sufficiently reiterates the above interpretation by indicating the significance of the differences of the means and of the adjusted means of the criterion tests for the experimental and the control groups:

CRITERION VARIABLES:
MEANS, SIGNIFICANCE OF DIFFERENCE OF MEANS,
ADJUSTED MEANS, SIGNIFICANCE OF DIFFERENCE OF ADJUSTED MEANS.

	MEANS			ADJUSTED MEANS		
VAR	SC2	SE2	z	SC2	SE2	F
COOP A	27.3	23.5	4.6^{**}	24.9	26.6	9.3^{++}
SMSG	16.7	15.2	2.9^{**}	15.3	17.1	13.7^{***}
VAR	AC2	AE2	z	AC2	AE2	F
COOP B	20.5	24.0	2.96^{**}	19.7	24.9	46.7^{***}
SMSG	14.8	17.1	2.39^{**}	14.2	17.8	32.0^{***}

**Sig. at .01 level
$^{++}$Sig. at .005 level
***Sig. at .001 level

10.3 Summary

In this hypotheses-testing phase of the experimental and control groups studying a particular "modern" curricula of the junior high school, the following results emerged from a statistical analysis of the second random half of the data:

(1) Correlation coefficients indicate that the initial measures of quantitative ability and of mathematical achievement are strongly related to criterion measures. This result is similar to that derived from the first half of the data.

(2) An analysis of the regression equations of this second random half of the data is indicated in order to test a conjecture derived from the exploratory investigation of the first random half. This conjecture was stated as a null hypothesis:

H_o: REGRESSION EQUATIONS AS PREDICTORS OF THE CRITERION VARIABLES ARE NOT SIGNIFICANT.

Result: H_o, the null hypothesis, is rejected at the .001 level; i.e., regression equations with initial tests as covariates are predictive of final test results.

An analysis of RSQ and regression coefficients indicates that in the second half of the data, as well as in the first half, initial scores of quantitative ability and of mathematical achievement are the strongest predictors (among the independent variables) of the criterion variables.

(3) Investigation of homogeneity in the exploratory examination of data led to the proposal of another conjecture, to be tested here in the null hypothesis form.

H_o: HETEROGENEITY OF REGRESSION OF THE CRITERION VARIABLES ON THE PREDICTOR VARIABLES IS INDICATED AT A SIGNIFICANT LEVEL.

Result: H_o, the null hypothesis, is rejected at the .05 level. The degree of heterogeneity is not significant since $p \nless .05$; i.e., homogeneity of regression conjectured in the exploratory investigation is reconfirmed here in the analysis of covariance using the second half of the data.

(4) In the exploratory phase comparing mean scores on initial tests led to a conjecture to be tested here in the null hypotheses form:

H_o: THERE IS NO SIGNIFICANT DIFFERENCE ON THE INITIAL SCORES OF THE EXPERIMENTAL AND THE CONTROL GROUPS ON INITIAL TESTING.

Result: H_o, the null hypothesis, is rejected at the .001 level for the arithmetic groups. For the algebra groups: H_o is rejected at .025 level ($.01 < p < .025$) for SCAT Q; judgment is withheld for the acceptance or rejection of H_o for DAV L and COOP ARITH ($.05 < p < .10$); H_o is accepted for DAV S ($.10 < p < .25$) and for SCAT V ($p > .25$).

(5) Significance tests on final test scores of the first random half of the data led to a tentative conclusion, stated here as a null hypothesis and to be tested in this form as usual:

> H_o: EXPERIMENTAL AND CONTROL GROUPS ARE NOT SIGNIFICANTLY DIFFERENT ON CRITERION VARIABLES AFTER ADJUSTING WITH COVARIATES.

Investigation revealed a significant difference between adjusted mean scores of experimental and control groups on final testing. For the ARITH groups, while the control group was significantly higher (.01 level) on actual scores, the experimental group was significantly higher (.005 level for COOP, and .001 for SMSG) on adjusted scores. For the ALG groups, while the actual scores did not differ significantly on the exploratory investigation, the experimental group on this subsequent analysis was significantly higher than the control group (.01 level); the adjusted scores accentuate the significance of the higher achievement of the experimental group over the control group (.001 level). Therefore, in this hypothesis-testing phase, H_o, the null hypothesis, is rejected at the .001 level for the SMSG final tests and the COOP algebra test, and is rejected at the .005 level for the COOP arithmetic test.

The conjectures, based on results of an investigation of a random half of the data and proposed as null hypotheses, have now been tested on the other half of the data. These results and other aspects of the study have implications for future research, and many of these will be discussed explicitly or implicitly in the remaining chapters.

PART III IMPLICATIONS

CHAPTER 11

STATISTICAL ANALYSIS

Proposals for additional investigations of the secondary school slow-learner may be inferred from several sources of the present study: statistical analysis, content scales, class observations, and student selection.

In previous chapters a detailed analysis has been reported in two parts: the hypotheses-generating phase with a randomly selected half of the population, followed by the hypotheses-testing phase with the remainder of the population.

The resulting statistics of the present study have indicated an important result: IF THE SCHOOLS' CLASSIFICATION OF THE "SLOW-LEARNER" IS USED, THEN IT HAS BEEN SHOWN THAT THESE STUDENTS SHOW A GREATER GAIN IN ACHIEVEMENT IN THE "NEW" MATHEMATICS, WHEN A "MODIFIED MODERN" TEXT IS STUDIED, AND WHEN THE PACE OF INSTRUCTION IS LESS RAPID. Analogous research under other conditions will verify and extend, or qualify in some aspects, the results of this study.

CHAPTER 12

CONTENT SCALES

12.1 Source

In an effort to investigate the degree to which students learn particular skills and understand certain concepts, content sub-scales of the two levels of SMSG final tests were developed. These were listed in section 7.3; the complete statistical analysis appears with the criterion tests in Appendix A; the Cronbach alpha of these scales may be found in Appendix B(V).

Unfortunately, these scales did not yield conclusive results on differences of performance of the "slow-learners" on component parts of content, but many conjectures might be drawn from the analysis of these content subscales of the SMSG final tests. The number of items in the subscales is too limited to pursue at any great length in this study, but analysis of content scales provides a rich source of ideas for future research. A few of these conjectures follow:

12.2 Prediction

The value of regression analysis lies not only in ascertaining the prediction of one variable from another but even more so in apportioning the effects of the factors and in assessing the relative contributions of each. The raw score regression weights displayed in Appendix A (If, IIf, IIIf, IVf) involve different units of measure and must be converted to beta coefficients in order to estimate the relative contribution of the independent variables as predictors of the dependent variables.

12.3 Prediction of Reading Scale

Of the variance in the score of the Reading scale attributable to initial tests, the strongest predictors were mathematic achievement and quantitative ability, not the verbal or reading initial scores. Yet, teachers of long experience maintain that poor reading is a deterrent to mathematical success. Perhaps, the standardized tests which measure verbal aptitude and reading facility do not get at the kind of reading essential in mathematics problems, where often the crux of a question is in the interpretation of a single word or a phrase. Therefore, as a suggestion for future research, the following null hypothesis is proposed:

H_o: MEASURES OF READING SKILLS AND VERBAL ABILITY HAVE PREDICTIVE POWER EQUAL TO THAT OF QUANTITATIVE ABILITY AND MATHEMATICS ACHIEVEMENT SCORES ON ITEMS REQUIRING INTERPRETATION OF WORDS INTO MATHEMATICAL SYMBOLS.

12.4 Reading Skill as Predictor

There appears to be some evidence that the Davis Speed of Comprehension contributes more to the variance of the criterion variables of the control classes than of the experimental classes, who proceeded at a slower pace. There appears, however, even stronger evidence that of the two Davis Reading scales, Level of Comprehension is the better predictor for junior high school pre-algebra, and Speed of Comprehension is the better predictor for algebra. Therefore, the following null hypothesis is proposed:

H_o: LEVEL OF COMPREHENSION OF READING AND SPEED OF COMPREHENSION OF READING HAVE EQUAL WEIGHTS IN PREDICTING MATHEMATICS ACHIEVEMENT IN JUNIOR HIGH SCHOOL PRE-ALGEBRA AND ALGEBRA.

12.5 Prediction of "New" Topics

The initial tests explain less of the variance of the GEOmetry, COOrdinates, and INEquality scales than any of the other scales. Since these are recent additions to the junior high school curriculum, particularly the courses for less able students, future investigation here seems fruitful. The following summary table (Appendix A (If, IIf, IIIf, IVf)) indicates the total variances attributable to the independent variables for each of the dependent variables, including the sub-scales:

PERCENTAGE OF VARIANCE OF DEPENDENT VARIABLES
ATTRIBUTABLE TO INDEPENDENT VARIABLES

DEP VAR	SC1	SE1	SC2	SE2
COOP A	75	57	74	61
SMSG	66	40	61	45
SON	69	45	62	46
FDP	65	41	53	37
GEO	36	22	38	30
REA	60	38	61	42
TSB	69	42	64	49

DEP VAR	AC1	AE1	AC2	AE2
COOP B	61	24	54	39
SMSG	44	29	54	26
E&I	40	30	49	25
INE	31	33	28	18
AEX	42	30	48	24
FSP	38	24	41	25
APS	40	28	51	27
COO	29	10	14	14
REA	43	26	45	22
TSB	45	31	51	27

Therefore, the following null hypothesis is proposed:

H_o: AN EQUAL PERCENTAGE OF VARIANCE IS ATTRIBUTABLE TO ABILITY, READING, AND MATHEMATICS ACHIEVEMENT FOR "NEW TOPICS" (SUCH AS INEQUALITIES, COORDINATE AND NON-METRIC GEOMETRY) AS FOR MORE "TRADITIONAL" ONES.

12.6 "Other Factors" as Predictors

It is also evident in the table above that the amount of variance attributable to initial tests is considerably less for the experimental groups than for the control groups. This is true even for the AC2-AE2 groups, which *appeared* so similar in their initial means. In classifying their students into "slow" and "fast" groups, schools are intuitively employing other factors. As one coordinator wrote,

> Very careful evaluation . . . has gone into this [selection of the slow-learners] . . . You will note that *not all* the students assigned . . . rank between the 50th and 25th percentile in Achievement or Mental Capacity. We emphasize that . . . they are all "slow-learners" because of one or more basic reasons. Many factors are taken into consideration in making these groupings . . .

It is possible but by no means certain that these "other factors" should be considered as predictor variables, though identification and measurement of these variables will be no small task. Therefore, this null hypothesis is proposed:

H_o: THE VARIANCE OF ACHIEVEMENT MEASURES ATTRIBUTABLE TO INITIAL SCORES OF ABILITY, READING AND MATHEMATICS ACHIEVEMENT, IS EQUAL FOR ABOVE-AVERAGE, AVERAGE, AND BELOW-AVERAGE CLASSES.

12.7 Arithmetic Sub-scores as Predictors

There is some evidence that of the three SRA scales (Reasoning, Concepts, and Computation), Concepts is the strongest predictor (often equal to or greater than SCAT Quantitative), and Computation is the weakest predictor. Therefore, this null hypothesis is proposed:

> H_o: MEASURES OF REASONING, CONCEPTS, AND COMPUTATION SCALES OF ACHIEVEMENT ARE EQUAL IN PREDICTING ACHIEVEMENT IN THE "NEW" PRE-ALGEBRA MATHEMATICS.

CHAPTER 13

CLASS OBSERVATIONS

Observations of the interaction of students, teachers, and mathematics point strongly to a need for studies in

(a) the value of visual aids in enhancing learning, particularly in the non-metric geometry;

(H_o: THERE IS NO SIGNIFICANT DIFFERENCE IN THE ACHIEVEMENT OF STUDENTS STUDYING GEOMETRY WITH AND WITHOUT VISUAL AIDS.)

(b) effect of grades, pacing, and choice of topics on motivation of the "slow-learner";

(H_o: STUDENTS MOTIVATED BY THE THREAT OF POOR GRADES ACHIEVE EQUALLY WITH THOSE WHO RECEIVE THE SAME INSTRUCTION WITHOUT THIS THREAT.)

(c) cognitive levels reached by "slow-learners";

(H_o: WITH SLOW PACING, STUDENTS WHO ARE BELOW-AVERAGE IN ABILITY REACH THE SAME COGNITIVE LEVEL AS AVERAGE STUDENTS.)

(d) relevance of the affective domain in teaching classes designated as "slow-learners". For example, if commitment to learning could be assessed, this might be a strong predictor.

(H_o: "COMMITMENT TO LEARNING" IS EQUAL IN PREDICTIVE POWER TO ABILITY, READING, AND ACHIEVEMENT.)

CHAPTER 14

STUDENT SELECTION

14.1 Composition of Classes

"Slow-learners", the experimental groups, were roughly defined to be in the second lowest quartile, and the "control classes" the next quartile above. In choosing students to benefit by the "slow-learner" study, some schools used previous standardized test scores, or teachers' recommendations, but, in general, the study classes chosen by principals, teachers, counselors, or coordinators were existing classes of low-achievers. The initial reasons for children being placed in these classes varied, e.g.:

(a) below grade level in mathematics achievement
(b) inadequate reading level
(c) slow worker in mathematics
(d) inaccurate computation
(e) fearful of mathematics
(f) antagonistic toward school
(g) apathetic, indifferent toward learning
(h) recent transfers to school
(i) chronic absentee

There was no doubt in the minds of the teachers and administrators, from whom this list was compiled, that the study classes were composed of "slow-learners." Perhaps, each of these students sees himself as he is seen; he performs as he is expected to perform. After years of poor work habits and lack of commitment to learning, he sees himself as a slow-learner.

Somehow, this pattern needs to be interrupted. The study gave

2

some students their first chance to taste success in mathematics. This might account for some of the individual successes about which teachers wrote such glowing descriptions. The study provided the impetus for escaping the classification of "slow-learner." There is, on the other hand, reason to scrutinize the possible danger that being forced to study mathematics at such a slow pace frustrates above-average children. Undesirable work habits and negative attitudes ensue.

Bar graphs in the Appendix B (VI) depict lucidly the composition of the classes. They reveal the heterogeneity of the experimental and control classes on each of the predictor variables, based on national norms published for each of the tests.

14.2 Implications of Selection

Several observations are in order:

(a) The "slow-learner" classes were homogeneous only to the extent that they were "low-achievers." The appropriateness of the same curriculum and the desirability of the same pacing of this curriculum for this continuum of abilities and skills are open to question both from the viewpoint of learning mathematics and from the viewpoint of developing a positive attitude toward mathematics.

(b) Measurement on the initial battery attests to the reluctance of school authorities to permit many of the below average students to study algebra -- even as an experiment over a period of two years.

(c) Initial tests of the experimental arithmetic classes indicated an abundance of children satisfying the required quartile criteria, but also even more in the lowest quartile, particularly on reading and computation. These children provide a continuing problem concerning the appropriateness of curriculum for them.

(d) Something more than pencil-and-paper tests of ability, reading, and achievement go into the school's classification of the "slow-learner." Every teacher familiar with the non-achievers can cite countless cases of youngsters who are not below-average mentally, but who through years of disuse of their mental powers have virtually no skills necessary for survival in classes geared for their intellectual level. The low-achievers' understanding, skills and attitudes toward school and learning are not attune with the students in the above-average classes. Reluctant to display his ignorance, he saves face by not trying, thereby never failing something he has tried. In classes which are geared for the student who grasps concepts only with laborious effort, the misplaced non-achiever is bored, critical, and often becomes a serious behavior problem. He learns little; his grades remain low; and so the situation is perpetuated for him year after year.

This assignment of above-average students to "slow" classes is not unique to this study. In the 1963-64 evaluation of the BSCS (Biological Sciences Curriculum Study) Special Materials Program, it is apparent that this is a common problem in trying out materials for the slow-learner. Some excerpts concerning their selection of students for the SM classes will illustrate how common this problem is.[5]

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[5] The Biological Sciences Curriculum Study, BSCS Newsletter 24, Evaluation Issue (Boulder, Colorado: BSCS, 1964); in particular pp. 18-19. This pilot year gave valuable insight in the planning of future experimentation with SM materials. See BSCS Special Publication 4, The Teacher and BSCS Special Materials (Boulder, Colorado: Biological Sciences Curriculum Study, 1966).

SELECTION OF STUDENTS FOR SM CLASSES

> . . . there are a number of different kinds of unsuccessful learners. There are underachievers . . . who are not performing up to capacity for one reason or another. These may be students with psychological problems or they may be students who lack motivation or are simply lazy. The SM materials are not designed for this type of student . . . When [these students] are assigned to a slow-learner class, this may simply aggravate the psychological problem at the same time it gives the school a sense that it is solving a problem which is certainly not being solved, but, rather, is being avoided . . . To use SM materials with a group of underachievers may result in further boring bright youngsters, failing to motivate them, or confirming the student's incorrect judgment that he is not really very bright and therefore cannot be expected to perform particularly well. . .
>
> . . . The controlling factor in sectioning for the SM classes too often appears to be a matter of convenience in scheduling . . .
>
> . . . If the situation [faulty method of class assignment] in the experimental schools is typical of that in other schools, this would seem to reflect a serious educational problem which should be looked at by school administrators.

CHAPTER 15

SUMMARY

These questions and hosts of others are awaiting investigation. This study indicates that time does make a difference, but the question of the optimum time has not been answered. For example, perhaps two years is too long to spend on algebra. Children might learn more and with more positive attitudes if three years are spent on an integrated algebra and geometry course. Some other time interval, some other topics, might be even more effective.

Unanswered questions face us at every turn. How does the teaching procedure differ for slow-learners, or should it differ? When we refer to "slow-learners," on what range of abilities is the focus? 40th - 50th percentile? 25th - 50th percentile? Even lower? How much of the "modern" curriculum is appropriate for those under the 30th percentile? This study indicated that of the initial battery of tests, the strongest predictors of mathematical success of youngsters, defined as "slow-learners" by their schools, seemed to be their pre-test scores of quantitative ability and of mathematical achievement. This is a beginning but further research is urgently needed.

APPENDIX A

STATISTICAL ANALYSIS

CONTENTS

TITLE OF TABLE	SC1-SE1		SC2-SE2		AC1-AE1		AC2-AE2	
	TABLE	PAGES	TABLE	PAGES	TABLE	PAGES	TABLE	PAGES
Covariates, dependent variables, N	I.a.	58	II.a.	71	III.a.	84	IV.a.	100
Raw score means, standard deviations	I.b.	59	II.b.	72	III.b.	85	IV.b.	101
Correlation matrix for control group.	I.c.	60	II.c.	73	III.c.	86	I.V.c.	102
Correlation matrix for experimental group	I.d.	60	II.d.	73	III.d.	86	I.V.d.	102
Univariate analysis of variance on predictor variables	I.e.	61-62	II.e.	74-75	III.e.	87-88	IV.e.	103-104
Raw score regression weights, RSQ, test of homogeneity of regression, analysis of co-variance: for COOP & SMSG for SMSG subscales	I.f.	63-64 65-66 67-68 69	II.f.	76-77 78-79 80-81 82	III.f.	89-90 91-92 93-94 95-96 97-98	IV.f.	105-106 107-108 109-110 111-112 113-114
Adjusted means of criterion variables.	I.g.	70	II.g.	83	III.g.	99	IV.g.	115

APPENDIX A "SLOW-LEARNER" GROUP SC1-SE1

TABLE I.a. VARIABLES[1]

COVARIATES

1	SCAT Q
2	SCAT V
3	DAV S
4	DAV L
5	SRA REAS
6	SRA CONC
7	SRA COMP

DEPENDENT VARIABLES

8	COOP A
9	SMSG
10	SON
11	FDP
12	GEO
13	REA
14	TSB

SAMPLE SIZES

SC1 GROUP 1, N = 172
SE1 GROUP 2, N = 122

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[1] See Chapter 7 for more complete information.

APPENDIX A "SLOW-LEARNER" GROUP SC1-SE1

TABLE I.b.

RAW SCORE MEANS

VARIABLES BY GROUPS

VARIABLE	(SC1) GROUP 1	(SE1) GROUP 2
SCAT Q	31.674	24.410
SCAT V	42.831	32.516
DAV S	28.448	13.721
DAV L	18.267	9.959
SRA REAS	21.326	16.902
SRA CONC	17.151	13.2[illegible]
SRA COMP	22.686	18.197
COOP A	28.006	23.705
SMSG	16.953	16.197
SON	11.919	10.770
FDP	5.337	4.615
GEO	3.390	3.598
REA	9.238	9.230
TSB	15.791	14.926

STANDARD DEVIATIONS

VARIABLES BY GROUPS

VARIABLE	(SC1) GROUP 1	(SE1) GROUP 2
SCAT Q	9.764	7.352
SCAT V	10.509	10.251
DAV S	15.650	11.310
DAV L	8.887	7.621
SRA REAS	7.336	6.434
SRA CONC	4.871	4.230
SRA COMP	8.134	6.510
COOP A	8.155	7.242
SMSG	5.704	5.214
SON	4.251	3.690
FDP	2.227	1.998
GEO	1.752	1.812
REA	3.703	3.574
TSB	5.523	5.104

TABLE I.c.

CORRELATION MATRIX FOR GROUP 1 (SC1)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SCAT Q		72	67	69	71	72	72	81	78	80	76	56	73	80
2	SCAT V			78	77	58	69	48	67	66	63	60	49	62	65
3	DAV S				91	55	64	47	69	66	62	59	51	65	66
4	DAV L					52	67	41	67	66	62	59	51	64	65
5	SRA REAS						59	65	74	66	71	71	45	63	70
6	SRA CONC							55	71	67	64	65	54	63	67
7	SRA COMP								69	62	66	62	41	59	64
8	COOP A									79	79	74	55	72	79
9	SMSG										93	85	73	93	97
10	SON											90	57	90	96
11	FDP												53	79	87
12	GEO													72	76
13	REA														95
14	TSB														

N = 172

TABLE I.d.

CORRELATION MATRIX FOR GROUP 2 (SE1)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SCAT Q		50	54	52	56	54	63	67	51	53	54	37	46	52
2	SCAT V			74	72	47	57	42	48	45	47	48	32	41	45
3	DAV S				92	56	51	46	54	46	47	40	33	44	46
4	DAV L					55	52	40	49	46	45	41	36	45	46
5	SRA REAS						56	63	61	49	53	47	33	49	50
6	SRA CONC							51	54	52	53	49	38	51	53
7	SRA COMP								59	48	55	50	32	48	51
8	COOP A									69	71	62	55	66	71
9	SMSG										93	85	82	92	98
10	SON											87	63	88	95
11	FDP												61	77	86
12	GEO													82	83
13	REA														95
14	TSB														

N = 122

TABLE I.e. UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- SCAT Q

Source of Variation	SS	DF	MS	F
BETWEEN	3766.71	1	3766.71	48.15
WITHIN	22841.28	292	78.22	
TOTAL	26607.99	293		

UNIVARIATE ANOVA ON -- SCAT V

Source of Variation	SS	DF	MS	F
BETWEEN	7594.16	1	7594.16	70.18
WITHIN	31598.58	292	108.21	
TOTAL	39192.74	293		

UNIVARIATE ANOVA ON -- DAV S

Source of Variation	SS	DF	MS	F
BETWEEN	15478.61	1	15478.61	78.80
WITHIN	57359.05	292	196.44	
TOTAL	72837.66	293		

UNIVARIATE ANOVA ON -- DAV L

Source of Variation	SS	DF	MS	F
BETWEEN	4926.95	1	4926.95	70.07
WITHIN	20532.49	292	70.32	
TOTAL	25459.45	293		

TABLE I.e. (continued) UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- SRA REAS

Source of Variation	SS	DF	MS	F
BETWEEN	1396.88	1	1396.88	28.70
WITHIN	14212.59	292	48.67	
TOTAL	15609.47	293		

UNIVARIATE ANOVA ON -- SRA CONC

Source of Variation	SS	DF	MS	F
BETWEEN	1102.28	1	1102.28	51.72
WITHIN	6223.09	292	21.31	
TOTAL	7325.38	293		

UNIVARIATE ANOVA ON -- SRA COMP

Source of Variation	SS	DF	MS	F
BETWEEN	1438.48	1	1438.48	25.55
WITHIN	16442.33	292	56.31	
TOTAL	17880.80	293		

TABLE I.f. REGRESSION WEIGHTS, TEST OF HOMOGENEITY, RSQ, ANALYSIS OF COVARIANCE

DEPENDENT VARIABLE -- COOP A

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.243	-.027	.106	.008	.268	.282	.151	.75
GROUP 2 (SE1)	.342	.006	.198	-.209	.257	.216	.116	.57

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .346 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	13348.078	7.	1906.868	96.887
TREATMENT MEANS	169.522	1.	169.522	8.613
HETEROGENEITY OF REGRESSION	47.622	7.	6.803	.346
ERROR	5471.408	278.	19.681	
TOTAL	19036.631	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 5.539

TABLE I.f. (continued)

DEPENDENT VARIABLE -- SMSG

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.210	.018	.028	.078	.115	.141	.067	.66
GROUP 2 (SE1)	.126	.038	-.010	.079	.094	.248	.097	.40

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .339 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	4415.232	7.	630.747	45.467
TREATMENT MEANS	588.975	1.	588.975	42.455
HETEROGENEITY OF REGRESSION	32.940	7.	4.706	.339
ERROR	3856.636	278.	13.873	
TOTAL	8893.783	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.786

TABLE I.f. (continued)

DEPENDENT VARIABLE -- SON

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.186	-.001	.012	.041	.141	.029	.065	.69
GROUP 2 (SE1)	.070	.038	.004	.015	.082	.154	.123	.45

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .979 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	2754.582	7.	393.512	58.455
TREATMENT MEANS	160.310	1.	160.310	23.813
HETEROGENEITY OF REGRESSION	46.157	7.	6.594	.979
ERROR	1871.468	278.	6.732	
TOTAL	4832.517	293.		

DIFFERENCE OF UNADJUSTED MEANS $z = 3.039$

TABLE I.f. (continued)

DEPENDENT VARIABLE -- FDP

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.078	-.008	.001	.023	.095	.063	.019	.65
GROUP 2 (SE1)	.064	.049	-.038	.028	.033	.058	.053	.41

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.210 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	741.023	7.	105.860	50.591
TREATMENT MEANS	28.124	1.	28.124	13.440
HETEROGENEITY OF REGRESSION	17.728	7.	2.533	1.210
ERROR	581.713	278.	2.092	
TOTAL	1368.588	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 3.367

TABLE I.f. (continued)

DEPENDENT VARIABLE -- GEO

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.046	-.000	.019	.002	.012	.079	-.002	.36
GROUP 2 (SE1)	.034	.002	-.021	.062	.011	.077	.019	.22

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .180 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	198.748	7.	28.393	12.203
TREATMENT MEANS	76.824	1.	76.824	33.018
HETEROGENEITY OF REGRESSION	2.936	7.	.419	.180
ERROR	646.826	278.	2.327	
TOTAL	925.333	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 0.588

TABLE I.f. (continued)

DEPENDENT VARIABLE -- REA

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.121	-.005	.035	.047	.075	.082	.042	.60
GROUP 2 (SE1)	.034	.007	-.029	.103	.068	.197	.100	.38

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .605 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	1610.721	7.	230.103	33.687
TREATMENT MEANS	352.253	1.	352.253	51.571
HETEROGENEITY OF REGRESSION	28.947	7.	4.135	.605
ERROR	1898.885	278.	6.831	
TOTAL	3890.806	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 0.541

TABLE I.f. (continued)

DEPENDENT VARIABLE -- TSB

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC1)	.227	.004	.031	.050	.147	.116	.064	.69
GROUP 2 (SE1)	.110	.036	-.036	.106	.085	.243	.146	.42

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .612 WITH 7 AND 278 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	4442.052	7.	634.579	51.574
TREATMENT MEANS	506.770	1.	506.770	41.187
HETEROGENEITY OF REGRESSION	52.751	7.	7.536	.612
ERROR	3420.566	278.	12.304	
TOTAL	8422.140	293.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.962

TABLE I.g.

ADJUSTED MEANS

VARIABLES BY GROUPS

VARIABLE	(SC1) GROUP 1	(SE1) GROUP 2
COOP A	25.492	27.250
SMSG	15.280	18.557
SON	10.733	12.442
FDP	4.740	5.456
GEO	2.985	4.169
REA	8.183	10.717
TSB	14.171	17.210

APPENDIX A "SLOW-LEARNER" GROUP SC2-SE2

TABLE II.a. VARIABLES[1]

COVARIATES

1	SCAT Q
2	SCAT V
3	DAV S
4	DAV L
5	SRA REAS
6	SRA CONC
7	SRA COMP

DEPENDENT VARIABLES

8	COOP A
9	SMSG
10	SON
11	FDP
12	GEO
13	REA
14	TSB

SAMPLE SIZES

(SC2) GROUP 1, N = 187
(SE2) GROUP 2, N = 140

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[1] See Chapter 7 for more complete information.

TABLE II.b.

RAW SCORE MEANS

VARIABLES BY GROUPS

VARIABLE	(SC2) GROUP 1	(SE2) GROUP 2
SCAT Q	30.283	23.500
SCAT V	40.930	32.036
DAV S	26.364	15.379
DAV L	17.508	10.579
SRA REAS	21.075	16.614
SRA CONC	16.727	13.600
SRA COMP	22.316	18.179
COOP A	27.299	23.464
SMSG	16.743	15.179
SON	11.690	10.157
FDP	5.182	4.314
GEO	3.535	3.386
REA	9.150	8.779
TSB	15,642	14.029

STANDARD DEVIATIONS

VARIABLES BY GROUPS

VARIABLE	(SC2) GROUP 1	(SE2) GROUP 2
SCAT Q	10.783	8.339
SCAT V	10.340	11.355
DAV S	15.950	12.272
DAV L	9.241	7.879
SRA REAS	7.434	5.722
SRA CONC	5.051	4.148
SRA COMP	8.352	6.585
COOP A	8.907	7.338
SMSG	5.861	5.394
SON	4.368	4.089
FDP	2.238	2.018
GEO	1.791	1.918
REA	3.828	3.546
TSB	5.684	5.386

APPENDIX A "SLOW-LEARNER" GROUP SC2-SE2

TABLE II.c.

CORRELATION MATRIX FOR GROUP 1 (SC2)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SCAT Q		70	68	70	68	67	78	81	74	77	69	51	73	76
2	SCAT V			81	80	55	60	51	66	59	59	55	51	64	63
3	DAV S				92	61	59	56	66	62	61	56	54	67	65
4	DAV L					56	60	54	65	61	61	56	51	66	65
5	SRA REAS						61	66	71	64	64	62	47	62	65
6	SRA CONC							63	72	65	62	59	54	65	66
7	SRA COMP								75	68	68	63	52	65	69
8	COOP A									75	75	71	55	72	77
9	SMSG										95	88	75	94	98
10	SON											91	58	90	96
11	FDP												60	84	90
12	GEO													77	77
13	REA														95
14	TSB														

N = 187

TABLE II.d.

CORRELATION MATRIX FOR GROUP 2 (SE2)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	SCAT Q		56	49	55	55	58	60	68	61	64	57	41	59	64
2	SCAT V			72	77	42	37	36	52	44	42	37	34	44	46
3	DAV S				90	52	42	46	45	35	34	29	26	33	36
4	DAV L					50	48	43	53	45	43	39	39	43	48
5	SRA REAS						52	63	52	39	39	32	30	38	41
6	SRA CONC							45	62	44	45	35	31	40	45
7	SRA COMP								52	34	40	37	20	35	37
8	COOP A									73	74	63	51	70	75
9	SMSG										93	81	74	94	98
10	SON											87	50	88	95
11	FDP												42	77	83
12	GEO													73	75
13	REA														95
14	TSB														

N = 140

TABLE II.e. UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- SCAT Q

Source of Variation	SS	DF	MS	F
BETWEEN	3684.00	1	368.00	38.26
WITHIN	31294.98	325	96.29	
TOTAL	34978.98	326		

UNIVARIATE ANOVA ON -- SCAT V

Source of Variation	SS	DF	MS	F
BETWEEN	6334.19	1	6334.19	54.45
WITHIN	37806.92	325	116.33	
TOTAL	44141.11	326		

UNIVARIATE ANOVA ON -- DAV S

Source of Variation	SS	DF	MS	F
BETWEEN	9661.11	1	9661.11	46.00
WITHIN	68254.21	325	210.01	
TOTAL	77915.32	326		

UNIVARIATE ANOVA ON -- DAV L

Source of Variation	SS	DF	MS	F
BETWEEN	3844.32	1	3844.32	50.97
WITHIN	24512.87	325	75.42	
TOTAL	28357.19	326		

UNIVARIATE ANOVA ON -- SRA REAS

Source of Variation	SS	DF	MS	F
BETWEEN	1592.96	1	1592.96	34.91
WITHIN	14830.12	325	45.63	
TOTAL	16423.08	326		

UNIVARIATE ANOVA ON -- SRA CONC

Source of Variation	SS	DF	MS	F
BETWEEN	782.99	1	782.99	35.66
WITHIN	7136.69	325	21.96	
TOTAL	7919.68	326		

UNIVARIATE ANOVA ON -- SRA COMP

Source of Variation	SS	DF	MS	F
BETWEEN	1370.19	1	1370.19	23.44
WITHIN	19000.92	325	58.46	
TOTAL	20371.11	326		

TABLE II.f. REGRESSION WEIGHTS, TEST OF HOMOGENEITY, RSQ, ANALYSIS OF COVARIANCE

DEPENDENT VARIABLE -- COOP A

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.263	.075	.011	.020	.203	.352	.213	.74
GROUP 2 (SE2)	.279	.114	-.136	.195	.101	.488	.116	.61

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .981 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	16363.878	7.	2337.697	108.390
TREATMENT MEANS	200.254	1.	200.254	9.285
HETEROGENEITY OF REGRESSION	148.054	7.	21.151	.981
ERROR	6707.455	311.	21.567	
TOTAL	23419.641	326.		

DIFFERENCE OF UNADJUSTED MEANS z = 4.638

TABLE II.f. (continued)

DEPENDENT VARIABLE -- SMSG

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.161	.007	.019	.045	.106	.209	.125	.61
GROUP 2 (SE2)	.307	.045	-.132	.231	.087	.104	-.066	.45

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.869 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	5510.067	7.	737.152	51.933
TREATMENT MEANS	208.050	1.	208.050	13.726
HETEROGENEITY OF REGRESSION	198.316	7.	28.331	1.869
ERROR	4713.806	311.	15.157	
TOTAL	10630.239	326.		

DIFFERENCE OF UNADJUSTED MEANS $z = 2.848$

TABLE II.f. (continued)

DEPENDENT VARIABLE -- SON

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.168	.011	.002	.035	.079	.093	.078	.62
GROUP 2 (SE2)	.254	.023	-.088	.147	.021	.074	.005	.46

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.044 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	3362.686	7.	480.384	57.921
TREATMENT MEANS	57.995	1.	57.995	6.993
HETEROGENEITY OF REGRESSION	60.606	7.	8.658	1.044
ERROR	2579.343	311.	8.294	
TOTAL	6060.630	326.		

DIFFERENCE OF UNADJUSTED MEANS $z = 3.595$

TABLE II.f. (continued)

DEPENDENT VARIABLE -- FDP

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.062	.009	.006	.006	.059	.054	.036	.53
GROUP 2 (SE1)	.114	.009	-.050	.088	-.002	-.004	.019	.37

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.570 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	729.036	7.	104.148	40.677
TREATMENT MEANS	4.808	1.	4.808	1.878
HETEROGENEITY OF REGRESSION	28.132	7.	4.019	1.570
ERROR	796.268	311.	2.560	
TOTAL	1558.245	326.		

DIFFERENCE OF UNADJUSTED MEANS $z = 3.929$

TABLE II.f. (continued)

DEPENDENT VARIABLE -- GEO

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	-.009	.020	.029	-.012	.007	.083	.047	.38
GROUP 2 (SE2)	.064	.007	-.077	.152	.050	.008	-.037	.30

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 3.304 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	287.482	7.	41.069	17.411
TREATMENT MEANS	33.865	1.	33.865	14.357
HETEROGENEITY OF REGRESSION	54.558	7.	7.794	3.304
ERROR	733.570	311.	2.359	
TOTAL	1109.474	326.		

DIFFERENCE OF UNADJUSTED MEANS z = 0.893

TABLE II.f. (continued)

DEPENDENT VARIABLE -- REA

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.092	.022	.030	.043	.048	.126	.057	.61
GROUP 2 (SE2)	.196	.042	-.094	.144	.060	.020	-.019	.42

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.926 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	2084.517	7.	297.788	44.424
TREATMENT MEANS	225.352	1.	225.352	33.618
HETEROGENEITY OF REGRESSION	90.363	7.	12.909	1.926
ERROR	2084.740	311.	6.703	
TOTAL	4484.973	326.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.235

TABLE II.f. (continued)

DEPENDENT VARIABLE -- TSB

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	SRA RE	SRA CO	SRA CO	RSQ
GROUP 1 (SC2)	.160	.037	.026	.037	.082	.177	.124	.64
GROUP 2 (SE2)	.321	.039	-.161	.290	.082	.072	-.041	.49

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 2.154 WITH 7 AND 311 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	5647.562	7.	806.795	59.934
TREATMENT MEANS	212.194	1.	212.194	15.763
HETEROGENEITY OF REGRESSION	202.995	7.	28.999	2.154
ERROR	4186.466	311.	13.461	
TOTAL	10249.218	326.		

DIFFERENCE OF UNADJUSTED MEANS z = 2.952

TABLE II.g.

ADJUSTED MEANS

VARIABLES BY GROUPS

VARIABLE	(SC2) GROUP 1	(SE2) GROUP 2
COOP A	24.915	26.649
SMSG	15.317	17.084
SON	10.634	11.567
FDP	4.695	4.964
GEO	3.166	3,879
REA	8,203	10.043
TSB	14.187	15.972

TABLE III.a. VARIABLES[1]

COVARIATES

1	SCAT Q
2	SCAT V
3	DAV S
4	DAV L
5	COOP A

DEPENDENT VARIABLES

6	COOP B
7	SMSG
8	E AND I
9	INE
10	AEX
11	FSP
12	APS
13	COO
14	REA
15	TSB

SAMPLE SIZES

(AC1) GROUP 1, N = 109
(AE1) GROUP 2, N = 89

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[1] See Chapter 7 for more complete information.

TABLE III.b.

RAW SCORE MEANS

VARIABLES BY GROUPS

VARIABLE	(AC1) GROUP 1	(AE1) GROUP 2
SCAT Q	30.055	24.101
SCAT V	36.697	33.371
DAV S	41.156	35.449
DAV L	23.890	20.528
COOP A	30.881	27.236
COOP B	21.110	20.944
SMSG	15.009	15.978
E AND I	7.275	7.921
INE	3.440	3.831
AEX	6.798	7.596
FSP	2.972	3.854
APS	10.413	11.393
COO	1.541	1.809
REA	6.339	6.607
TSB	14.018	15.202

STANDARD DEVIATIONS

VARIABLES BY GROUPS

VARIABLE	(AC1) GROUP 1	(AE1) GROUP 2
SCAT Q	8.239	5.667
SCAT V	12.007	7.667
DAV S	18.608	13.541
DAV L	9.362	6.821
COOP A	8.016	5.326
COOP B	7.492	7.179
SMSG	5.849	5.143
E AND I	3.440	3.314
INE	1.838	1.792
AEX	3.382	3.085
FSP	1.941	1.922
APS	3.923	3.629
COO	1.351	1.224
REA	3.053	2.596
TSB	5.738	4.964

TABLE III.c.

CORRELATION MATRIX FOR GROUP 1 (AC1)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	SCAT Q		57	55	54	83	72	64	60	51	61	53	61	41	63	64
2	SCAT V			87	82	65	42	44	44	42	45	40	41	29	49	44
3	DAV S				93	62	46	48	47	44	49	47	46	37	52	49
4	DAV L					57	38	46	45	42	44	43	43	35	49	46
5	COOP A						76	65	62	55	62	59	63	50	63	66
6	COOP B							77	72	63	74	63	72	64	72	79
7	SMSG								91	78	92	82	95	77	90	98
8	E AND I									87	87	76	90	74	91	94
9	INE										81	63	75	65	81	82
10	AEX											80	89	65	92	95
11	FSP												83	66	73	81
12	APS													69	87	96
13	COO														65	77
14	REA															93
15	TSB															

N = 109

TABLE III.d.

CORRELATION MATRIX FOR GROUP 2 (AE1)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	SCAT Q		17	26	20	54	30	41	41	39	44	35	41	19	40	43
2	SCAT V			77	64	21	09	07	11	13	07	-03	05	-01	09	06
3	DAV S				89	34	17	19	15	16	20	14	15	06	19	17
4	DAV L					34	12	13	09	09	14	10	10	04	16	11
5	COOP A						39	37	42	47	39	35	36	24	38	39
6	COOP B							72	65	52	70	71	72	43	68	71
7	SMSG								89	75	89	75	91	71	89	96
8	E AND I									86	79	69	90	71	87	94
9	INE										74	53	71	65	71	80
10	AEX											79	87	55	87	92
11	FSP												83	54	67	78
12	APS													60	88	96
13	COO														54	72
14	REA															92
15	TSB															

N = 89

TABLE III.e. UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- SCAT Q

Source of Variation	SS	DF	MS	F
BETWEEN	1736.83	1	1736.83	33.51
WITHIN	10157.76	196	51.83	
TOTAL	11894.59	197		

UNIVARIATE ANOVA ON -- SCAT V

Source of Variation	SS	DF	MS	F
BETWEEN	542.15	1	542.15	5.12
WITHIN	20741.77	196	105.83	
TOTAL	21283.92	197		

UNIVARIATE ANOVA ON -- DAV S

Source of Variation	SS	DF	MS	F
BETWEEN	1595.49	1	1595.49	5.84
WITHIN	53532.37	196	273.12	
TOTAL	55127.87	197		

UNIVARIATE ANOVA ON -- DAV L

Source of Variation	SS	DF	MS	F
BETWEEN	553.73	1	553.73	8.00
WITHIN	13560.86	196	69.19	
TOTAL	14114.59	197		

TABLE III.e. (continued) UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- COOP A

Source of Variation	SS	DF	MS	F
BETWEEN	650.87	1	650.87	13.52
WITHIN	9435.50	196	48.14	
TOTAL	10086.37	197		

TABLE III.f. REGRESSION WEIGHTS, TEST OF HOMOGENEITY, RSQ, ANALYSIS OF COVARIANCE

DEPENDENT VARIABLE -- COOP B

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.311	-.178	.201	-.276	.508	.61
GROUP 2 (AE1)	.143	-.058	.150	-.237	.430	.24

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

$F = .608$ WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	4216.419	5.	843.284	26.344
TREATMENT MEANS	331.162	1.	331.162	10.436
HETEROGENEITY OF REGRESSION	97.315	5.	19.463	.608
ERROR	5953.858	186.	32.010	
TOTAL	10598.753	197.		

DIFFERENCE OF UNADJUSTED MEANS $z = 0.431$

TABLE III.f. (continued)

DEPENDENT VARIABLE -- SMSG

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.227	-.089	.082	-.002	.248	.44
GROUP 2 (AE1)	.261	-.097	.122	-.140	.192	.29

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .220 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	1790.204	5.	358.041	17.580
TREATMENT MEANS	468.206	1.	468.206	22.989
HETEROGENEITY OF REGRESSION	22.359	5.	4.472	.220
ERROR	3788.120	186.	20.366	
TOTAL	6068.889	197.		

DIFFERENCE OF UNADJUSTED MEANS $z = 0.969$

TABLE III.f. (continued)

DEPENDENT VARIABLE -- E AND I

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.100	-.039	.025	.036	.159	.40
GROUP 2 (AE1)	.142	.010	.048	-.126	.193	.30

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .674 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	600.666	5.	120.133	15.160
TREATMENT MEANS	163.328	1.	163.328	20.611
HETEROGENEITY OF REGRESSION	26.709	5.	5.342	.674
ERROR	1473.943	186.	7.924	
TOTAL	2264.646	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.123

TABLE III.f. (continued)

DEPENDENT VARIABLE -- INE

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.034	-.013	.012	.020	.079	.31
GROUP 2 (AE1)	.057	.014	.024	-.076	.134	.33

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.122 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	148.242	5.	29.648	12.241
TREATMENT MEANS	42.494	1.	42.494	17.544
HETEROGENEITY OF REGRESSION	13.586	5.	2.717	1.122
ERROR	450.506	186.	2.422	
TOTAL	654.828	197.		

DIFFERENCE OF UNADJUSTED MEANS $z = 1.428$

TABLE III.f. (continued)

DEPENDENT VARIABLE -- AEX

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.131	-.033	.069	-.054	.121	.42
GROUP 2 (AE1)	.162	-.067	.081	-.090	.124	.30

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .163 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	579.383	5.	115.877	16.237
TREATMENT MEANS	191.541	1.	191.541	26.839
HETEROGENEITY OF REGRESSION	5.824	5.	1.165	.163
ERROR	1327.398	186.	7.137	
TOTAL	2104.146	197.		

DIFFERENCE OF UNADJUSTED MEANS $z = 1.546$

TABLE III.f. (continued)

DEPENDENT VARIABLE -- FSP

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.031	-.048	.043	-.003	.103	.38
GROUP 2 (AE1)	.072	-.085	.066	-.061	.080	.24

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .634 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	156.619	5.	31.324	11.527
TREATMENT MEANS	99.414	1.	99.414	36.584
HETEROGENEITY OF REGRESSION	8.620	5.	1.724	.634
ERROR	505.433	186.	2.717	
TOTAL	770.086	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 3.113

TABLE III.f. (continued)

DEPENDENT VARIABLE -- APS

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.136	-.076	.061	-.003	.178	.40
GROUP 2 (AE1)	.181	-.059	.073	-.104	.143	.28

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .287 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	730.965	5.	146.193	14.639
TREATMENT MEANS	266.002	1.	266.002	26.637
HETEROGENEITY OF REGRESSION	14.324	5.	2.865	.287
ERROR	1857.461	186.	9.986	
TOTAL	2868.753	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.542

TABLE III.f. (continued)

DEPENDENT VARIABLE - COO

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	-.003	-.040	.017	.020	.088	.29
GROUP 2 (AE1)	.019	-.019	.014	-.019	.046	.10

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .755 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	48.882	5.	9.776	6.896
TREATMENT MEANS	14.421	1.	14.421	10.173
HETEROGENEITY OF REGRESSION	5.349	5.	1.070	.755
ERROR	263.676	186.	1.418	
TOTAL	332.328	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.461

TABLE III.f. (continued)

DEPENDENT VARIABLE -- REA

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.124	-.013	.038	-.001	.090	.43
GROUP 2 (AE1)	.125	-.029	.030	-.019	.104	.26

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .201 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	482.201	5.	96.440	17.536
TREATMENT MEANS	92.498	1.	92.498	16.819
HETEROGENEITY OF REGRESSION	5.533	5.	1.107	.201
ERROR	1022.945	186.	5.500	
TOTAL	1603.177	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 0.409

TABLE III.f. (continued)

DEPENDENT VARIABLE -- TSB

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC1)	.195	-.099	.088	-.007	.279	.45
GROUP 2 (AE1)	.255	-.103	.124	-.160	.206	.31

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .338 WITH 5 AND 186 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	1730.724	5.	346.145	18.289
TREATMENT MEANS	510.051	1.	510.051	26.950
HETEROGENEITY OF REGRESSION	31.979	5.	6.396	.338
ERROR	3520.241	186.	18.926	
TOTAL	5792.995	197.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.304

TABLE III.g.

ADJUSTED MEANS

VARIABLES BY GROUPS

VARIABLE	(AC1) GROUP 1	(AE1) GROUP 2
COOP B	19.763	22.593
SMSG	13.932	17.297
E AND I	6.672	8.660
INE	3.160	4.174
AEX	6.189	8.342
FSP	2.672	4.222
APS	9.713	12.250
COO	1.396	1.987
REA	5.787	7.283
TSB	12.972	16.484

TABLE IV.a. VARIABLES[1]

COVARIATES

1	SCAT Q
2	SCAT V
3	DAV S
4	DAV L
5	COOP A

DEPENDENT VARIABLES

6	COOP B
7	SMSG
8	E AND I
9	INE
10	AEX
11	FSP
12	APS
13	COO
14	REA
15	TSB

SAMPLE SIZES

(AC2) GROUP 1, N = 106
(AE2) GROUP 2, N = 95

---

[1] See Chapter 7 for more complete information.

TABLE IV.b.

RAW SCORE MEANS

VARIABLES BY GROUPS

	(AC2)	(AE2)
VARIABLE	GROUP 1	GROUP 2
SCAT Q	28.802	26.063
SCAT V	33.613	34.305
DAV S	36.745	32.842
DAV L	21.774	19.221
COOP A	29.623	27.926
COOP B	20.519	23.989
SMSG	14.792	17.147
E AND I	7.425	8.139
INE	3.321	3.874
AEX	6.642	8.358
FSP	3.019	3.905
APS	10.557	12.053
COO	1.472	1.811
REA	6.066	7.432
TSB	13.849	16.168

STANDARD DEVIATIONS

VARIABLES BY GROUPS

	(AC2)	(AE2)
VARIABLE	GROUP 1	GROUP 2
SCAT Q	9.074	7.144
SCAT V	12.437	8.308
DAV S	18.941	16.910
DAV L	9.585	9.638
COOP A	7.798	5.447
COOP B	6.841	6.955
SMSG	5.666	5.560
E AND I	3.467	3.431
INE	1.935	1.632
AEX	3.220	3.172
FSP	1.794	1.963
APS	3.894	3.720
COO	1.244	1.475
REA	3.047	2.956
TSB	5.461	5.377

TABLE IV.c.

CORRELATION MATRIX FOR GROUP 1 (AC2)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	SCAT Q		42	38	37	79	71	71	69	53	64	53	70	37	64	70
2	SCAT V			90	83	59	50	51	43	28	50	52	50	23	48	49
3	DAV S				94	55	52	52	44	27	52	56	51	23	47	50
4	DAV L					51	49	47	41	25	47	53	47	23	43	46
5	COOP A						71	67	66	51	63	51	66	36	63	67
6	COOP B							76	65	52	72	63	71	41	64	72
7	SMSG								87	72	90	76	93	62	88	95
8	E AND I									88	84	65	88	63	91	94
9	INE										76	45	70	63	78	79
10	AEX											80	91	55	90	94
11	FSP												82	52	65	79
12	APS													56	89	96
13	COO														62	70
14	REA															93
15	TSB															

N = 106

TABLE IV.d.

CORRELATION MATRIX FOR GROUP 2 (AE2)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	SCAT Q		15	22	17	71	50	35	37	25	33	37	38	23	34	37
2	SCAT V			61	58	23	01	-05	07	07	-04	05	-05	03	-03	-02
3	DAV S				93	32	23	21	24	23	18	19	16	24	11	21
4	DAV L					23	14	16	18	20	10	10	09	21	05	14
5	COOP A						48	34	41	34	35	41	35	27	36	38
6	COOP B							76	71	52	68	70	72	63	68	76
7	SMSG								92	75	89	81	94	78	92	98
8	E AND I									86	79	74	88	79	86	93
9	INE										72	55	70	66	76	77
10	AEX											83	90	55	88	91
11	FSP												86	60	72	83
12	APS													65	89	96
13	COO														65	77
14	REA															92
15	TSB															

N = 95

TABLE IV.e. UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- SCAT Q

Source of Variation	SS	DF	MS	F
BETWEEN	375.78	1	375.78	5.56
WITHIN	13442.46	199	67.55	
TOTAL	13818.24	200		

UNIVARIATE ANOVA ON -- SCAT V

Source of Variation	SS	DF	MS	F
BETWEEN	24.00	1	24.00	.21
WITHIN	22729.29	199	114.22	
TOTAL	22753.29	200		

UNIVARIATE ANOVA ON -- DAV S

Source of Variation	SS	DF	MS	F
BETWEEN	763.26	1	763.26	2.35
WITHIN	64548.75	199	324.37	
TOTAL	65312.01	200		

UNIVARIATE ANOVA ON -- DAV L

Source of Variation	SS	DF	MS	F
BEEWEEN	326.42	1	326.42	3.53
WITHIN	18378.92	199	92.36	
TOTAL	18705.34	200		

TABLE IV.e. (continued) UNIVARIATE ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- COOP A

Source of Variation	SS	DF	MS	F
BETWEEN	144.16	1	144.16	3.13
WITHIN	9173.39	199	46.10	
TOTAL	9317.55	200		

TABLE IV.f. REGRESSION WEIGHTS, TEST OF HOMOGENEITY, RSQ, ANALYSIS OF COVARIANCE

DEPENDENT VARIABLE -- COOP B

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.316	-.058	.132	-.049	.242	.54
GROUP 2 (AE2)	.316	-.188	.245	-.279	.253	.39

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .788 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	3721.104	5.	744.221	28.109
TREATMENT MEANS	1235.490	1.	1235.490	46.665
HETEROGENEITY OF REGRESSION	104.366	5.	20.873	.788
ERROR	5003.947	189.	26.476	
TOTAL	10064.906	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 2.964

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- SMSG

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.336	-.026	.165	-.150	.073	.54
GROUP 2 (AE2)	.167	-.204	.140	-.079	.162	.26

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.943 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	2074.147	5.	414.829	21.362
TREATMENT MEANS	622.136	1.	622.136	32.037
HETEROGENEITY OF REGRESSION	188.660	5.	37.732	1.943
ERROR	3670.261	189.	19.419	
TOTAL	6555.204	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 2.390

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- E AND I

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S.	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.181	-.039	.068	-.040	.097	.49
GROUP 2 (AE2)	.083	-.054	.057	-.032	.155	.25

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .497 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	795.334	5.	159.067	20.386
TREATMENT MEANS	108.367	1.	108.367	13.889
HETEROGENEITY OF REGRESSION	19.398	5.	3.880	.497
ERROR	1474.702	189.	7.803	
TOTAL	2397.801	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.073

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- INE

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.074	-.012	.019	-.023	.059	.28
GROUP 2 (AE2)	.006	-.025	.017	.006	.085	.18

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .769 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	125.642	5.	25.128	9.722
TREATMENT MEANS	34.825	1.	34.825	13.474
HETEROGENEITY OF REGRESSION	9.942	5.	1.988	.769
ERROR	488.485	189.	2.585	
TOTAL	658.896	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.790

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- AEX

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.156	-.026	.103	-.084	.055	.48
GROUP 2 (AE2)	.076	-.100	.099	-.104	.114	.24

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.450 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	583.864	5.	116.773	17.143
TREATMENT MEANS	261.107	1.	261.107	38.331
HETEROGENEITY OF REGRESSION	49.399	5.	9.880	1.450
ERROR	1287.431	189.	6.812	
TOTAL	2181.801	200.		

DIFFERENCE OF UNADJUSTED MEANS $z = 3.371$

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- FSP

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.078	-.010	.047	-.001	-.007	.41
GROUP 2 (AE2)	.047	-.026	.058	-.079	.089	.25

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.661 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	172.706	5.	34.541	13.669
TREATMENT MEANS	68.173	1.	68.173	26.978
HETEROGENEITY OF REGRESSION	20.986	5.	4.197	1.661
ERROR	477.608	189.	2.527	
TOTAL	739.473	200.		

DIFFERENCE OF UNADJUSTED MEANS $z = 3.009$

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- APS

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.216	-.022	.092	-.063	.070	.51
GROUP 2 (AE2)	.138	-.118	.111	-.119	.091	.27

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.686 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	961.851	5.	192.370	21.221
TREATMENT MEANS	253.445	1.	253.445	27.958
HETEROGENEITY OF REGRESSION	76.423	5.	15.285	1.686
ERROR	1713.307	189.	9.065	
TOTAL	3005.025	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 2.165

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- COO

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.031	-.004	.004	.005	.024	.14
GROUP 2 (AE2)	.015	-.036	.028	-.004	.047	.14

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = .309 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	40.275	5.	8.055	4.829
TREATMENT MEANS	14.641	1.	14.641	8.777
HETEROGENEITY OF REGRESSION	2.577	5.	.515	.309
ERROR	315.263	189.	1.668	
TOTAL	372.756	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 1.540

TABLE IV.f. (continued)

DEPENDENT VARIABLE -- REA

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.148	-.001	.067	-.065	.061	.45
GROUP 2 (AE2)	.064	-.063	.049	-.058	.135	.22

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.256 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	501.157	5.	100.231	16.053
TREATMENT MEANS	168.803	1.	168.803	27.035
HETEROGENEITY OF REGRESSION	39.197	5.	7.839	1.256
ERROR	1180.106	189.	6.244	
TOTAL	1889.264	200.		

DIFFERENCE OF UNADJUSTED MEANS $z = 2.727$

TABLE IV. f. (continued)

DEPENDENT VARIABLE -- TSB

RAW SCORE REGRESSION WEIGHTS

	SCAT Q	SCAT V	DAV S	DAV L	COOP A	RSQ
GROUP 1 (AC2)	.299	-.029	.128	-.098	.110	.51
GROUP 2 (AE2)	.149	-.170	.158	-.138	.194	.27

TEST OF THE HYPOTHESIS OF HOMOGENEITY OF REGRESSION

F = 1.327 WITH 5 AND 189 DEGREES OF FREEDOM

ANALYSIS OF COVARIANCE

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
REGRESSION	1933.836	5.	386.767	21.019
TREATMENT MEANS	584.748	1.	584.748	31.779
HETEROGENEITY OF REGRESSION	122.094	5.	24.419	1.327
ERROR	3477.721	189.	18.401	
TOTAL	6118.398	200.		

DIFFERENCE OF UNADJUSTED MEANS z = 2.482

TABLE IV.g.

ADJUSTED MEANS

VARIABLES BY GROUPS

VARIABLE	(AC2) GROUP 1	(AE2) GROUP 2
COOP B	19.716	24.885
SMSG	14.172	17.840
E AND I	7.062	8.593
INE	3.172	4.040
AEX	6.329	8.706
FSP	2.864	4.078
APS	10.157	12.498
COO	1.366	1.929
REA	5.808	7.719
TSB	13.264	16.821

APPENDIX B

SUPPLEMENTARY MATERIAL

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APPENDIX B

SUPPLEMENTARY MATERIAL

I. Texts: SMSG "modified" junior high school and algebra texts.

The seventh grade youngsters studied the SMSG Introduction to Secondary School Mathematics; the ninth grade the SMSG Introduction to Algebra. A brief word of explanation about these texts is necessary.

The first pilot texts of the School Mathematics Study Group were written for "roughly the upper third of the students at each grade level when ranked by grades, achievement, or ability, or some such index, admittedly a vague delineation."[1]

The content selected for the junior high mathematics was rich with new topics, explored in a lively and imaginative way. Though some applications appeared in exercises, the emphasis was on mathematical reasoning, not on computation. Initial success of the pilot program for the college bound youngster, and the convictions of some members of the panel on the non-college bound student, encouraged SMSG to proceed with the assumption that slow learners could learn "good" mathematics without sacrificing depth, if the course were rewritten, approaching various levels of abstraction more slowly.

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[1] William Wooten, SMSG The Making of a Curriculum, Yale University Press, New Haven, 1965, p. 10.

Two writing teams were assigned the task of revising the existing material for a new audience -- an audience which might spend up to two years learning the mathematics on which the old audience was spending one year. In the rewriting, the task entailed use of simpler vocabulary, breaking longer sections into smaller bites, supplying some easier exercises, and at the same time taking care that the general depth and flavor of the original texts[2] were maintained. These "modified" versions were titled Introduction to Secondary School Mathematics and Introduction to Algebra. Teacher and student reactions were, in general, favorable when, as is customary, the pilot texts were studied the following year by a variety of classes.

II. Tests: (standardized)

SCAT: SCHOOL AND COLLEGE ABILITY TEST

(This test is highly related to academic success. It is primarily intended as a measure of the student's ability to succeed in future academic work.)

Form 4A: Initial battery for S (arithmetic)

---

[2] SMSG Junior High School Mathematics and SMSG First Course in Algebra.

APPENDIX B (continued)

Form 3A: Initial battery for A (algebra)

Two scores were used for variables:

Q: Quantitative (arithmetic reasoning and computation)

V: Verbal (sentence completion and vocabulary)

DAVIS: DAVIS READING TEST

(This test is especially useful in assessing over-all reading ability.)

Series 2, Form 2A: Initial battery for S (arithmetic)

Series 2, Form 3A: Initial battery for A (algebra)

Two scores were used as variables:

L: Level of comprehension (This score indicates the depth of understanding in reading.)

S: Speed of comprehension (This score indicates the rapidity and accuracy with which the student understands the same reading material.)

SRA: SCIENCE RESEARCH ASSOCIATES

(SRA ACHIEVEMENT SERIES: ARITHMETIC)

Form A: Initial battery for S (arithmetic)

Three scores were used as variables:

REAS: Arithmetic reasoning

CONC: Arithmetic concepts

COMP: Arithmetic computation

APPENDIX B (continued)

COOPERATIVE MATHEMATICS TESTS

(These tests measure achievement which is assessed in terms of students' comprehension of the basic concepts and techniques.) Two tests were used as variables:

COOP ARITH: Arithmetic

Form A: Initial battery for A (algebra)
Final battery for S (arithmetic)

COOP ALG: Algebra

Form B: Final battery for A (algebra)

III. Tests: "Block tests"

Achievement tests based on the texts were furnished all students. These "block tests," each composed of 35 multiple-choice questions, were administered and graded by the teachers at the end of specified chapters, and the results returned to SMSG.

Chapters of Texts / "Block test"	Introduction to Secondary School Mathematics	Introduction to Algebra
1	2-3	1-2
2	4-5	3-5
3	6-7	6-8
4	8-10	9-10
5	11-12	11-12
6	13-15	13-15
7	17-18	16-17
8	19-21	18-19

APPENDIX B (continued)

The return on "block test" scores and the corresponding number of teaching days spent on that same "block" of information was never very prolific, and reduced to a mere trickle after about mid-way in the course. Based on the sketchy information available, the relationship between the student scores and the amount of time the teacher spent on that particular block was somewhat inconsistent.

CORRELATION COEFFICIENTS FOR SCORES ON INDIVIDUAL BLOCK TESTS AND THE CORRESPONDING NUMBER OF TEACHING DAYS ON THE SAME BLOCK

$N \geq 117$

	Teaching Days on same block			
Scores on Block	SE1	SC1	AE1	AC1
1	.04	.08	-.03	-.02
2	-.32	-.39	-.02	-.35
3	-.20	-.30	.12	-.07
4	-.18	-.29	.31	.17
5	-.13	-.09	.22	-.16

The following chart illustrates how little uniformity there was in the number of days teachers felt was necessary to spend on each "block" of material.

APPENDIX B (continued)

CORRELATION COEFFICIENTS FOR TEACHING DAYS ON "BLOCK" UNITS

N $\geq$ 138

Block \ Block	2	3	4	Group
1	.52	.21	.24	SE1
	.27	.24	.23	SC1
	.26	.04	.03	AE1
	.45	.27	.23	AC1
2		.04	.38	SE1
		.75	-.63	SC1
		.07	-.27	AE1
		.78	-.63	AC1
3			.23	SE1
			-.61	SC1
			.18	AE1
			-.61	AC1

3

APPENDIX B (continued)

Consistency of difficulty from one test to the next is indicated by the strong relationships evidenced below:

CORRELATION COEFFICIENTS FOR "BLOCK TEST" SCORES

N $\geq$ 187

Block Block	2	3	4	Group
1	.76	.73	.71	SE1
	.74	.77	.71	SC1
	.70	.64	.55	AE1
	.79	.73	.63	AC1
2		.77	.68	SE1
		.73	.71	SC1
		.72	.55	AE1
		.77	.72	AC1
3			.73	SE1
			.77	SC1
			.66	AE1
			.74	AC1

APPENDIX B (continued)

It is interesting to note in the table below that there is a strong relationship between the "block test" scores and the final SMSG and COOP tests.

CORRELATION COEFFICIENTS
FOR SMSG "BLOCK TESTS" AND FINAL TESTS

$N \geq 184$

Block Tests / Final Tests	1	2	3	4	Group
ARITH (SMSG)	.66	.64	.67	.68	SE1
	.70	.70	.74	.71	SC1
ALG (SMSG)	.40	.46	.51	.55	AE1
	.65	.68	.68	.73	AC1
ARITH (COOP)	.72	.68	.71	.73	SE1
	.71	.71	.73	.78	SC1
ALG (COOP)	.45	.52	.60	.63	AE1
	.67	.75	.75	.74	AC1

Because of the preceding high correlations between the final tests and the "block tests," and because the information received on the last few "block tests" was insufficient for detailed analysis, the "block tests" were eliminated as criterion measures, and were, therefore, not incorporated into the study.

APPENDIX B (continued)

IV. MTAI: MINNESOTA TEACHER ATTITUDE INVENTORY

(It is designed to measure those attitudes of a teacher which are important in interpersonal relationships with pupils.)

A conjecture that there existed a positive relationship between teacher's MTAI scores and their students' initial and final scores was not verified. Based on the tests used in this study, the degree of relationship between teacher attitude and students achievement is not an auspicious one.

CORRELATION COEFFICIENTS FOR TEST SCORES AND MTAI

$N \geq 115$

MTAI Tests	Group			
	(SE1)	(SC1)	(AE1)	(AC1)
Initial				
SCAT Q	-.15	.04	.05	-.04
SCAT V	-.07	.01	.01	-.04
Dav S	-.03	.04	-.01	-.05
Dav L	-.03	-.12	-.08	-.08
SRA Reas	-.15	.07		
SRA Conc	-.10	-.06		
SRA Comp	-.21	-.02		
COOP Arith			-.04	.22
Final				
COOP Arith	-.10	-.01		
COOP Alg			.33	.02
SMSG Arith	-.06	.03		
SMSG Alg			.26	-.15

There is too little data to follow this further, for though the number of students is greater than one hundred, the number of teachers is obviously much smaller. To attempt further analysis would only lead to misinterpretation. However, this negligible correlation would be consistent with Gage's conclusion that while teachers' understanding of pupils is an objective of every teacher-education program, present evidence does not demonstrate that this understanding makes any difference.[3]

V. Cronbach Alpha

"α estimates, and is a lower bound to, the proportion of test variance attributable to common factors among the items. That is, it is an index of common-factor concentration. This index serves purposes claimed for indices of homogeneity. α may be applied by a modified technique to determine the common-factor concentration among a battery of subtests."[4]

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[3] N. L. Gage, "Explorations in Teachers' Perceptions of Pupils," J. Tch. Education, 1958, 9, pp. 97-100.

[4] Lee J. Cronbach, "Coefficient Alpha and the Internal Structure of Tests," Psychometrika, Vol. 16, No. 3, Sept., 1951, p. 331.

APPENDIX B (continued)

Cronbach's Alpha of SMSG Tests and Subscales of SMSG Tests

		Cronbach's Alpha	
	No. of items in scale	SE1 (N = 122)	SC1 (N = 172)
SMSG Arith Final	35	.76	.80
SON (Systems of Numbers)	21	.72	.78
FDP (Fractions, Decimals, Percentage)	9	.59	.70
GEO (Geometry)	9	.46	.50
REA (Reading)	21	.68	.71
TSB (Test subscale: most abstract items deleted)	31	.78	.81

		Cronbach's Alpha	
	No. of items in scale	AE1 (N = 89)	AC1 (N = 109)
SMSG Algebra Final	35	.77	.85
E&I (Equalities & Inequalities)	18	.69	.79
INE (Inequalities)	9	.50	.61
AEX (Algebraic Expressions)	16	.66	.80
FSP (Factoring, Special Products)	7	.59	.76
ASP (Application: Structure, Properties)	20	.71	.81
COO (Coordinates)	5	.29	.62
REA (Reading)	15	.59	.76
TSB (Test subscale: most abstract items deleted)	31	.78	.87

VI. COMPOSITION OF STUDY CLASSES

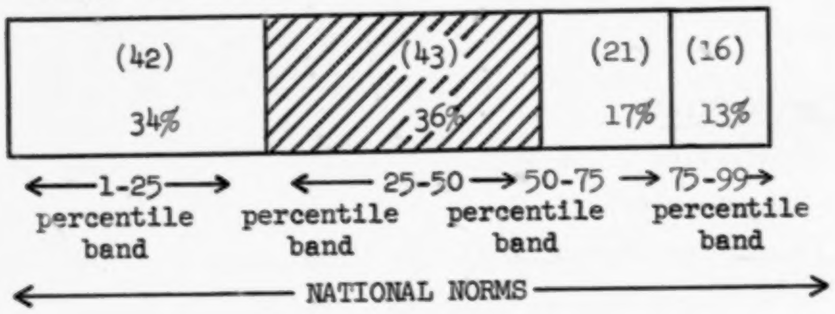
The groups selected by schools were not homogeneous, if by homogeneity the reference is to any scores of the initial testing. This is perhaps best illustrated by graphical means.

e.g., Using the SCAT Quantitative score:

Out of 122 students in the SEI group, 42 (34 percent) tested in the lowest quartile (based on national norms); 43 (36 percent), in the 25th-50th percentile band; 21 (17 percent), the 50th-75th percentile; 16 (13 percent), in the highest quartile.

SCAT QUANTITATIVE

100 percent of SE1 Group N = 122



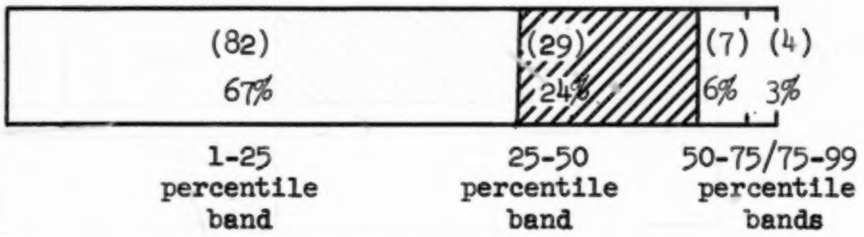
i.e., The 25th-50th percentile group, defined by the SCAT Quantitative score were in the position of being in the middle third of the class.

APPENDIX B (continued)

e.g., In an analysis of SRA Computation, it is more evident why these same students were placed in classes of "slow-learners."

SRA COMPUTATION

100 percent of SE1 Group N = 122



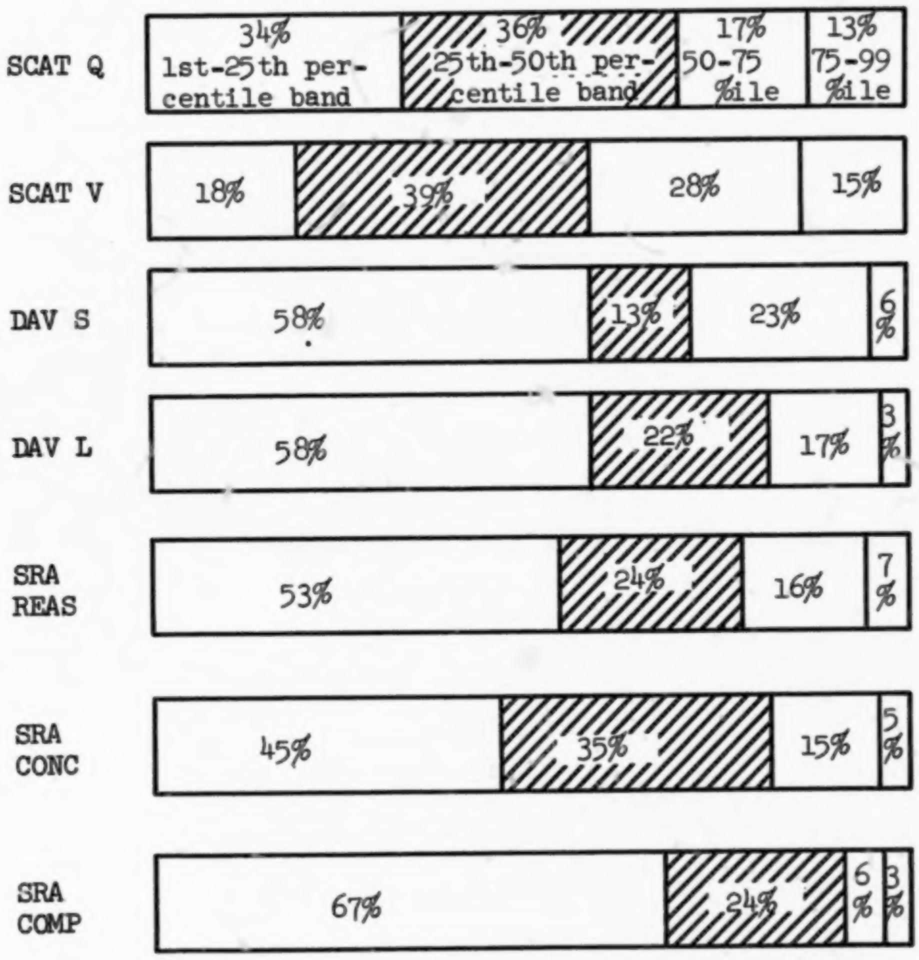
A summary follows in the next four pages:

APPENDIX B (continued)

VI. COMPOSITION OF STUDY CLASSES[1] (continued)

APPROXIMATE PERCENTAGE OF STUDENTS IN 25th-50th PERCENTILE BAND (NATIONAL NORMS),[2] AND RELATION OF STUDENTS IN 25th-50th PERCENTILE BAND TO STUDENTS IN OTHER QUARTILES[3] (NATIONAL NORMS).

100 of ARITH EXPERIMENTAL GROUP N = 122



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[1] Based on hypotheses-generating half.

[2] National norms as given in test manuals for SCAT, DAVIS, and SRA.

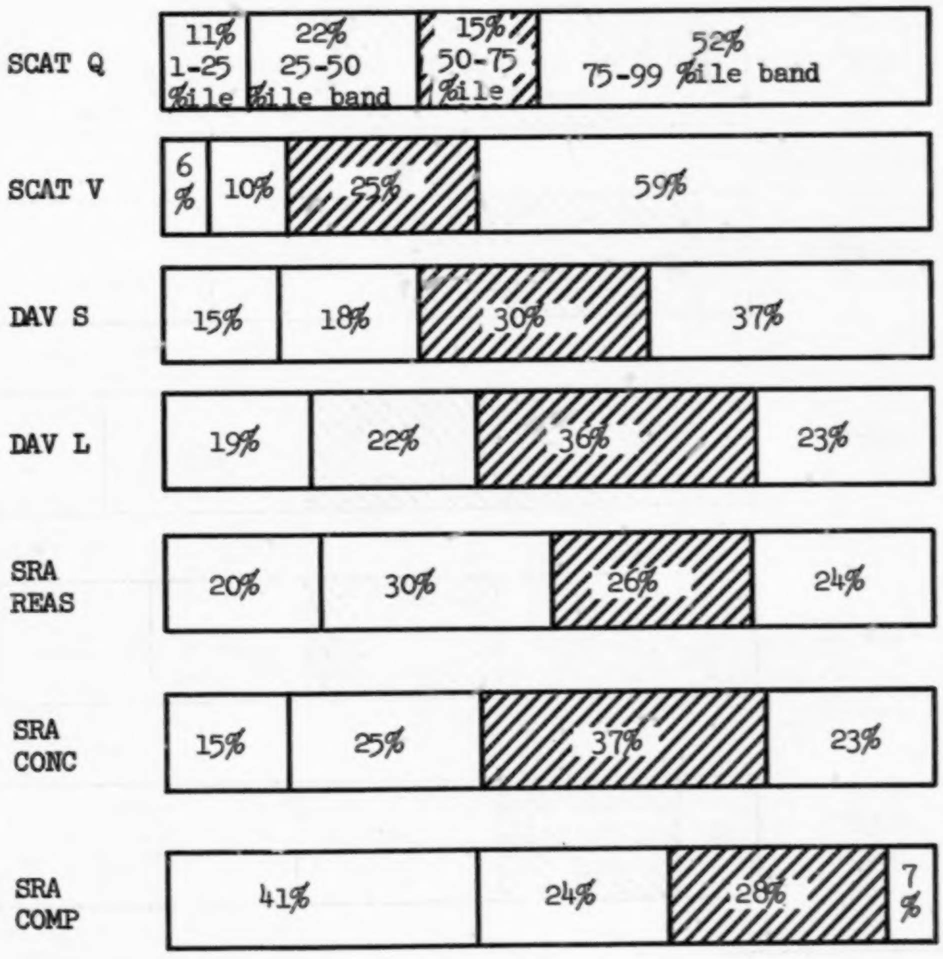
[3] Divisions into quartiles based on national norms; left to right: 25th %ile, 50th %ile, 75th %ile.

APPENDIX B (continued)

VI. COMPOSITION OF STUDY CLASSES[1] (continued)

APPROXIMATE PERCENTAGE OF STUDENTS IN 50th-75th PERCENTILE BAND (NATIONAL NORMS),[2] AND RELATION OF STUDENTS IN 50th-75th PERCENTILE BAND TO STUDENTS IN OTHER QUARTILES[3] (NATIONAL NORMS).

100 of ARITH CONTROL GROUP N = 172



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[1] Based on hypotheses-generating half.

[2] National norms as given in test manuals for SCAT, DAVIS, and SRA.

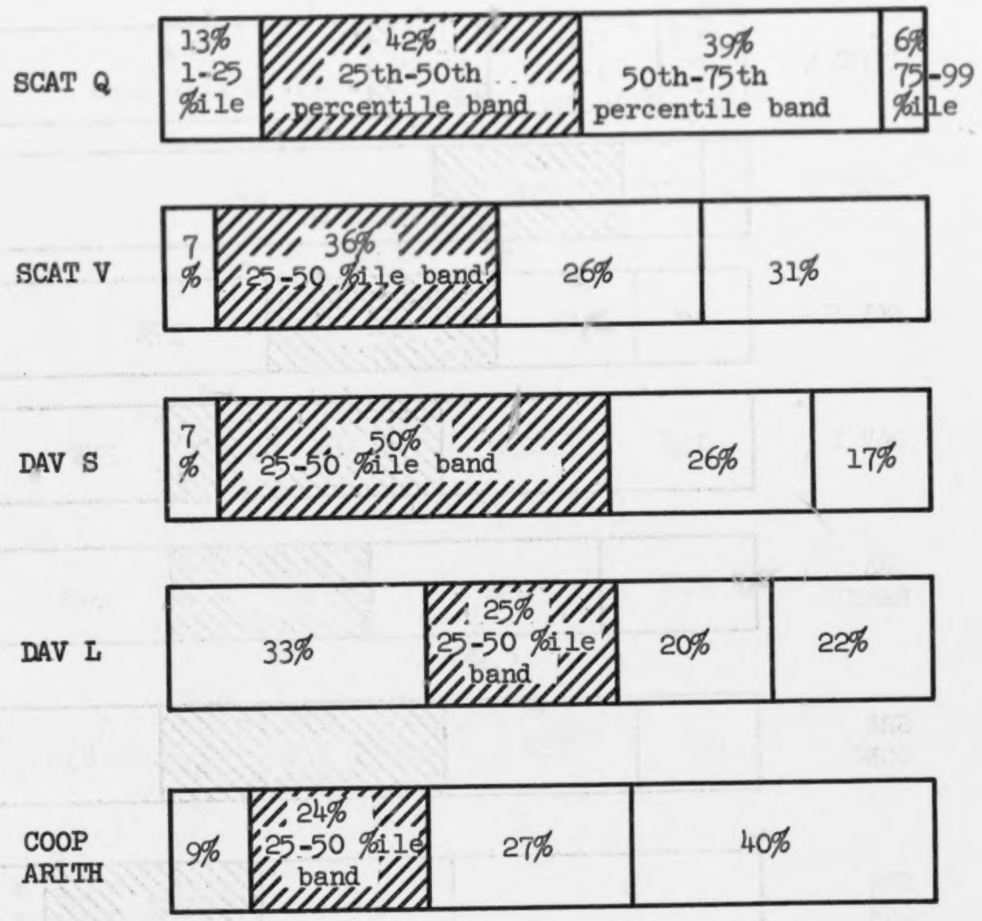
[3] Divisions into quartiles based on national norms; left to right: 25th %ile, 50th %ile, 75th %ile.

APPENDIX B (continued)

VI. COMPOSITION OF STUDY CLASSES[1] (continued)

APPROXIMATE PERCENTAGE OF STUDENTS IN 25th-50th PERCENTILE BAND (NATIONAL NORMS),[2] AND RELATION OF STUDENTS IN 25th-50th PERCENTILE BAND TO STUDENTS IN OTHER QUARTILES[3] (NATIONAL NORMS).

100 of ALG EXPERIMENTAL GROUP N = 89



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[1] Based on hypotheses-generating half.

[2] National norms as given in test manuals for SCAT, DAVIS, and COOP.

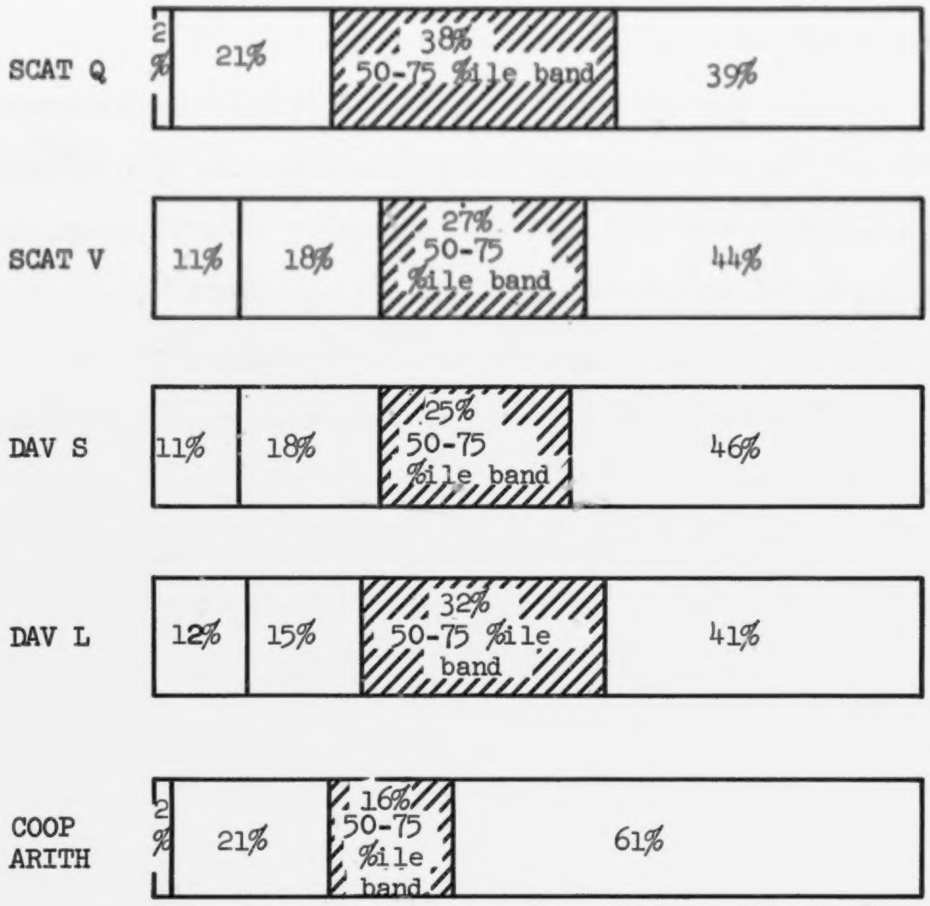
[3] Divisions into quartiles based on national norms; left to right: 25th %ile, 50th %ile, 75th %ile.

APPENDIX B (continued)

VI. COMPOSITION OF STUDY CLASSES[1] (continued)

APPROXIMATE PERCENTAGE OF STUDENTS IN 50^{th}-75^{th} PERCENTILE BAND (NATIONAL NORMS),[2] AND RELATION OF STUDENTS IN 50^{th}-75^{th} PERCENTILE BAND TO STUDENTS IN OTHER QUARTILES[3] (NATIONAL NORMS).

100 of ALGEBRA CONTROL GROUP N = 109



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[1] Based on hypotheses-generating half.

[2] National norms as given in test manuals for SCAT, DAVIS, and COOP.

[3] Divisions into quartiles based on national norms; left to right: 25th %ile, 50th %ile, 75th %ile.

VII. Student Questionnaire

The student questionnaire given at the end of the course contributed little to the study for these two reasons:

(a) The return of the questionnaires was light, reflecting a combination of poor communications between coordinators and teachers, and apathetic or negative feelings of teachers toward paper work and its consummation of additional class time.

(b) The questionnaire revealed little relevant information, because of its construction. The public relations with schools and with individual teachers were too tenuous to probe in sensitive areas which might reflect student opinions on good teaching. Since communications were channelled through department heads, principals, or district coordinators, such a threat to participating teachers was unjustified.

APPENDIX B (continued)

VIII.

ITEM ANALYSIS: SMSG ARITHMETIC FINAL: INTRODUCTION TO SECONDARY SCHOOL MATHEMATICS (ISSM)

EXPERIMENTAL GROUP (N=273)

ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)
1	.76	.64	13	.33	.47	25	.16	.06
2	.08	.35	14	.59	.65	26	.32	.24
3	.30	.32	15	.56	.19	27	.24	.39
4	.23	.25	16	.68	.44	28	.42	.52
5	.48	.47	17	.67	.57	29	.18	.26
6	.49	.32	18	.48	.41	30	.27	.29
7	.25	.24	19	.39	.36	31	.36	.30
8	.84	.49	20	.55	.48	32	.60	.44
9	.65	.01	21	.57	.42	33	.53	.41
10	.51	.29	22	.68	.38	34	.23	.09
11	.41	.43	23	.46	.52	35	.10	-.22
12	.60	.48	24	.52	.39			

CONTROL GROUP (N = 208)

ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)
1	.84	.58	13	.36	.54	25	.13	.13
2	.23	.61	14	.74	.52	26	.37	.57
3.	.19	.16	15	.50	.19	27	.18	.19
4	.19	.27	16	.80	.71	28	.77	.63
5	.61	.42	17	.79	.64	29	.25	.40
6	.60	.36	18	.61	.53	30	.33	.57
7	.25	.19	19	.25	.43	31	.54	.57
8	.92	.52	20	.62	.57	32	.76	.36
9	.65	.16	21	.63	.54	33	.66	.53
10	.47	.26	22	.61	.54	34	.24	.14
11	.13	.12	23	.69	.56	35	.09	.13
12	.68	.39	24	.66	.58			

PEARSON R (EVEN, ODD)	.64 (E) .67 (C)	CORRECTED SPLIT HALF	.78 (E) .80 (C)
CRONBACH'S ALPHA	.76 (E) .80 (C)	GUTTMAN L4	.78 (E) .79 (C)

APPENDIX B

VIII (continued)

ITEM ANALYSIS: SMSG ALGEBRA FINAL: INTRODUCTION TO ALGEBRA (IA)

EXPERIMENTAL GROUP (N=176)

ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)	ITEM NO.	MEAN	RBIS (NS)
1	.93	.18	13	.23	.20	25	.26	.23
2	.40	.37	14	.32	.28	26	.36	.27
3	.93	.60	15	.76	.35	27	.44	.59
4	.48	.49	16	.34	.45	28	.41	.47
5	.52	.42	17	.33	.43	29	.40	.36
6	.69	.47	18	.19	.13	30	.61	.43
7	.61	.43	19	.61	.61	31	.30	.30
8	.45	.66	20	.51	.45	32	.15	.53
9	.35	.30	21	.18	.30	33	.20	.28
10	.70	.53	22	.56	.23	34	.19	.13
11	.35	.50	23	.72	.21	35	.25	.19
12	.82	.52	24	.22	.05			

CONTROL GROUP (N=241)

1	.94	.38	13	.39	.43	25	.42	.67
2	.41	.60	14	.43	.65	26	.46	.45
3	.95	.42	15	.80	.55	27	.43	.60
4	.52	.52	16	.44	.46	28	.54	.50
5	.66	.53	17	.48	.56	29	.46	.48
6	.65	.61	18	.26	.22	30	.68	.57
7	.61	.73	19	.64	.59	31	.26	.36
8	.50	.68	20	.59	.44	32	.21	.57
9	.47	.45	21	.21	.53	33	.25	.28
10	.68	.80	22	.62	.36	34	.21	-.04
11	.44	.65	23	.76	.55	35	.27	.03
12	.85	.64	24	.26	.10			

PEARSON R (EVEN, ODD)	.68 (E) .78 (C)	CORRECTED SPLIT HALF	.81 (E) .88 (C)
CRONBACH'S ALPHA	.77 (E) .85 (C)	GUTTMAN L4	.81 (E) .88 (C)

APPENDIX B

School Mathematics Study Group
Introduction to Secondary School Mathematics
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DIRECTIONS:

This is a 35-minute test. You may do all of your work in the test booklet, but mark all of your answers on the separate answer sheet provided on the back of this page. Do not waste time on questions which you do not know how to answer.

You will put all your answers on the answer sheet. This test consists of 35 multiple-choice questions with five possible answers each. Mark your answer sheet by circling the letter of your answer as shown in the example below.

Example:

Multiply $\frac{2}{3}$ by $\frac{3}{4}$.

(A) $\frac{5}{12}$ (B) $\frac{1}{2}$ (C) $\frac{8}{9}$ (D) $\frac{9}{8}$ (E) 2

Sample Answer

A [✓ B] C D E

When you are ready to start the test, tear off this sheet, turn it over, and fill in the information asked for at the top: name, school and date.

Mark only one answer for each question. If you make a mistake or wish to change an answer, be sure to erase the first answer completely. Your score will be the number of problems you have answered correctly.

DO NOT TEAR OFF THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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Cedar Hall
Stanford University
Stanford, California

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School Mathematics Study Group

S Answer Sheet

Introduction to Secondary School Mathematics

Name______________________

School______________________

Teacher______________________

Student Identification No.

S __ __ __ __ __ __

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. A B C D E
16. A B C D E
17. A B C D E
18. A B C D E
19. A B C D E
20. A B C D E
21. A B C D E
22. A B C D E
23. A B C D E
24. A B C D E
25. A B C D E
26. A B C D E
27. A B C D E
28. A B C D E
29. A B C D E
30. A B C D E
31. A B C D E
32. A B C D E
33. A B C D E
34. A B C D E
35. A B C D E

USE THIS SPACE
FOR SCRATCHWORK

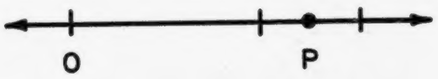
1. Which of the following decimals represents the largest quantity?

(A) .20
(B) .030
(C) .0045
(D) .0049
(E) .00099

2. Which one of the following is closest to $\frac{2}{3}$?

(A) .667
(B) .67
(C) .66
(D) .6
(E) .7

3. In the number line at the right, P represents any point. We can be CERTAIN that P represents



(A) a whole number.
(B) an integer.
(C) a rational number.
(D) an irrational number.
(E) a real number.

4. Which one of the following does NOT have the common name of zero?

(A) $0(\frac{-1}{2})$
(B) $[3 + (^{-}5)]0$
(C) $[(^{-}7 + 7)]14$
(D) $(^{-}1.0)(0.1)$
(E) $(^{-}23.18)(\frac{5}{5} - \frac{4}{4})$

USE THIS SPACE
FOR SCRATCHWORK

5. What number can you use for both squares to make this sentence INCORRECT?

$$3 \times 4 \times \square = \square \times 2 \times 6$$

(A) 0
(B) 1
(C) 12
(D) Every number is incorrect.
(E) No number is incorrect.

(6) Which one of the following numbers is a multiple of 3 and a divisor of 105 ?

(A) 6
(B) 9
(C) 21
(D) 35
(E) 210

7. The intersection of a triangle and a line CANNOT be

(A) an empty set.
(B) exactly 1 point.
(C) exactly 2 points.
(D) exactly 3 points.
(E) an infinite number of points.

8. 2^5 means the same as

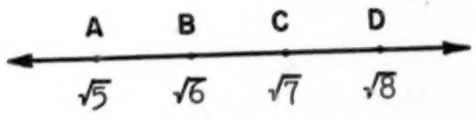
(A) 2×5
(B) 5×5
(C) $2 \times 2 \times 2 \times 2$
(D) $2 \times 2 \times 2 \times 2 \times 2$
(E) $2 + 2 + 2 + 2 + 2$

USE THIS SPACE
FOR SCRATCHWORK

9. John's weight increased from 100 pounds to 125 pounds in the last two years. His increase in weight is _______ % of his previous weight.

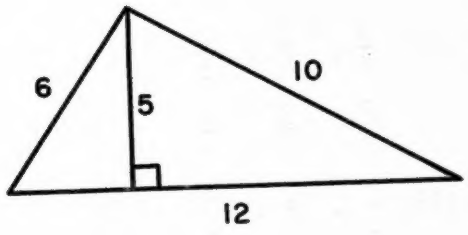
(A) 125
(B) 80
(C) 25
(D) 20
(E) None of these is correct.

10. Which of the points on the number line to the right represents a rational number?



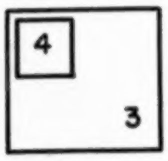
(A) A
(B) B
(C) C
(D) D
(E) None; all are irrational.

11. The area of the triangle shown at the right may be found by

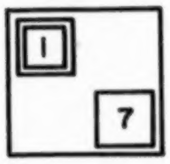


(A) adding 5 and 12.
(B) multiplying 5 by 12.
(C) adding 6, 10, and 12.
(D) multiplying $\frac{1}{2}$ by the product of 6 and 12.
(E) multiplying $\frac{1}{2}$ by the product of 5 and 12.

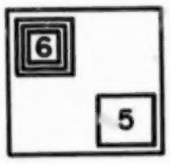
USE THIS SPACE
FOR SCRATCHWORK

12. If 

means 43

and 

means 170

what number does 

represent?

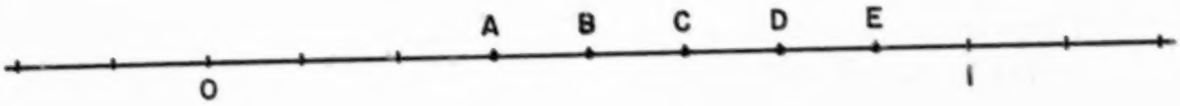
(A) 6655
(B) 6650
(C) 6050
(D) 650
(E) 65

13. In which of the following arrangements are the numbers in the order they appear on the number line (reading left to right from smallest to the largest)?

(A) $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{5}$
(B) $\frac{3}{4}$, $\frac{3}{5}$, $\frac{2}{3}$
(C) $\frac{2}{3}$, $\frac{3}{5}$, $\frac{3}{4}$
(D) $\frac{3}{5}$, $\frac{3}{4}$, $\frac{2}{3}$
(E) $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$

14. Which of the points A, B, C, D, or E on the number line corresponds to $\frac{3}{4}$?

USE THIS SPACE FOR SCRATCHWORK



(A) A
(B) B
(C) C
(D) D
(E) E

15. How many counting numbers are there on the number line between $19\frac{1}{2}$ and $30\frac{1}{2}$?

(A) 9
(B) 10
(C) 11
(D) 12
(E) 13

16. Express $\frac{3}{11}$ as a REPEATING decimal.

(A) $.27$
(B) $.0\overline{27}$
(C) $.\overline{027}$
(D) $.27\overline{27}$
(E) $.2727$

USE THIS SPACE
FOR SCRATCHWORK

17. Ted needs four pieces of wood $1\frac{1}{4}$ feet long for the legs of a small table. He has a 6-foot length board from which he plans to cut his four pieces. What length board will be left over?

(A) $\frac{1}{2}$ foot
(B) 1 foot
(C) $4\frac{3}{4}$ feet
(D) None; the 6-foot board is just the right length.
(E) The 6-foot board is not long enough.

18. Which one of the following division problems is correct?

(A) $.168 \div 3 = 5.6$
(B) $.168 \div .3 = 5.6$
(C) $.168 \div .03 = 5.6$
(D) $.168 \div .003 = 5.6$
(E) $.168 \div .0003 = 5.6$

19. The measure of one angle of a triangle is 90. Which of the following statements is NEVER true?

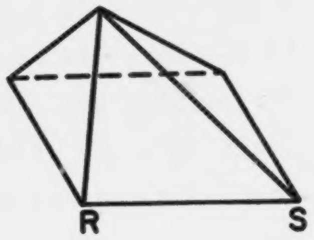
(A) The measure of one of the other angles may be 90.
(B) Neither of the other angles may be obtuse.
(C) Each of the other angles must be acute.
(D) The triangle may be isosceles.
(E) The triangle cannot be equilateral.

USE THIS SPACE
FOR SCRATCHWORK

20. What is the perimeter of a triangle if the distance around two of its sides is 10?

(A) 10
(B) 15
(C) 17.5
(D) 20
(E) It cannot be determined from the information given.

21. In the pyramid at the right, RS is an edge of the square base. How many edges of this solid have neither R nor S as an end point?



(A) 0
(B) 2
(C) 3
(D) 4
(E) 5

22. Suppose

$$2 \yen 5 = (2 \times 5) - (2 + 5) = 10 - 7 = 3$$

and $3 \yen 5 = (3 \times 5) - (3 + 5) = 15 - 8 = 7$

and $6 \yen 5 = (6 \times 5) - (6 + 5) = 30 - 11 = 19$

and so on.

Then what is $3 \yen 7$?

(A) 0
(B) 11
(C) 20
(D) 21
(E) 42

USE THIS SPACE
FOR SCRATCHWORK

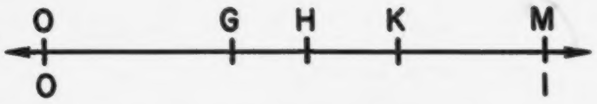
23. If you multiply a two-digit number by a two-digit number, what is the GREATEST possible answer you could get?

(A) 981
(B) 9,801
(C) 9,998
(D) 9,999
(E) 10,000

24. A parking strip which has space for 18 regular-size cars will be marked for parking small cars only. If 5 small cars can be parked in the space used by 3 regular-size cars, how many small cars will it be possible to park in the lot?

(A) 26
(B) 30
(C) 36
(D) 54
(E) 90

25. On the number line to the right the lengths of segments OM, OK, and GM are given. From this information, for which of the following segments can the length NOT be found?



(A) $\overline{OH}$
(B) $\overline{OG}$
(C) $\overline{GK}$
(D) $\overline{KM}$
(E) The lengths of all of the above segments can be found.

USE THIS SPACE
FOR SCRATCHWORK

26. Any whole number which ends in 9 is not a multiple of 5. It is also not a multiple of

(A) 3
(B) 6
(C) 7
(D) 11
(E) It could be a multiple of each of the above choices.

27. Consider the following statement:

If $\measuredangle a$ and $\measuredangle b$ are supplementary,
then $\measuredangle a$ and $\measuredangle b$ have equal measures.

The CONVERSE of this statement is

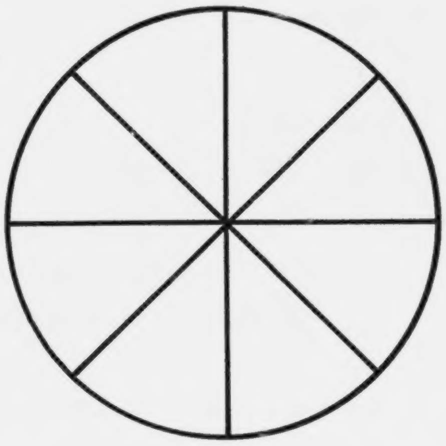
(A) always true.
(B) always false.
(C) true only if the angles are vertical angles.
(D) true only if the angles are adjacent angles.
(E) true only if the angles are right angles.

28. When counting in base seven the next number after 366_{seven} is

(A) 367
(B) 367_{seven}
(C) 370_{seven}
(D) 400_{seven}
(E) 466_{seven}

USE THIS SPACE
FOR SCRATCHWORK

29. Shown at the right are 8 spokes from the center of a wheel. The sum of the lengths of the spokes is ________ times the length of the diameter of the wheel.



(A) $\frac{1}{4}$

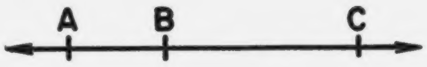
(B) $\frac{4}{\pi}$

(C) 4π

(D) 4

(E) It is impossible to say with the information given.

30. Find $\overleftrightarrow{AC} \cap \overrightarrow{BC}$



(A) $\overline{BC}$

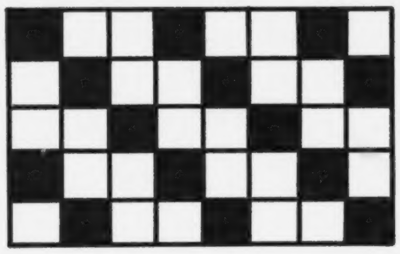
(B) $\overrightarrow{BC}$

(C) $\overleftrightarrow{BC}$

(D) $\overleftrightarrow{AC}$

(E) $\overrightarrow{AC}$

31. What percent of the figure at the right is darkened?



(A) 28

(B) 35

(C) 42

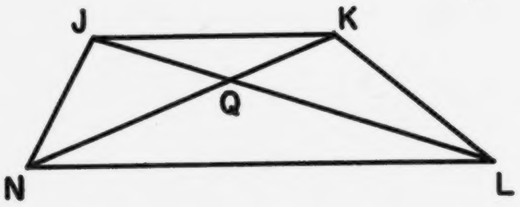
(D) 50

(E) 70

USE THIS SPACE
FOR SCRATCHWORK

32. In the figure at the right, find $\overrightarrow{NK} \cap \overleftrightarrow{KL}$.

(A) $\overline{NL}$
(B) point K
(C) $\angle$ NKL
(D) $\triangle$ NKL
(E) the empty set

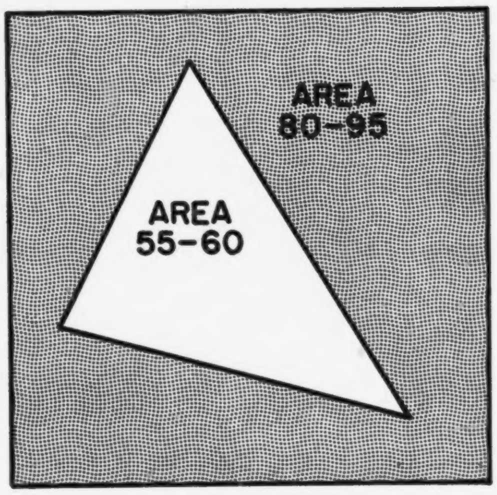


33. A football team has won 3 of the 6 games already played. If it wins the next four games, what percent of the games played will it then have won?

(A) 40
(B) 50
(C) 60
(D) 70
(E) 75

34. If the area of the triangle is between 55 and 60 square inches, and the area of the shaded region is between 80 and 95 square inches, the side of the square is approximately __________ inches.

(A) 10
(B) 11
(C) 12
(D) 13
(E) 14



35. Which of the following sums is INCORRECT?

USE THIS SPACE
FOR SCRATCHWORK

(A) $\frac{3}{k} + \frac{5}{k} = \frac{8}{k}$

(B) $4 + \frac{s}{4} = \frac{16 + s}{4}$

(C) $\frac{m}{n} + 1 = \frac{m + 1}{n}$

(D) $\frac{1}{r} + \frac{1}{t} = \frac{t + r}{rt}$

(E) None; each of the choices above is CORRECT.

APPENDIX B
IX. (continued)

School Mathematics Study Group
Introduction to Algebra
Part I and Part II
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DIRECTIONS:

This is a 35-minute test. You may do all of your work in the test booklet, but mark all of your answers on the separate answer sheet provided on the back of this page. Do not waste time on questions which you do not know how to answer.

You will put all your answers on the answer sheet. This test consists of 35 multiple-choice questions with five possible answers each. Mark your answer sheet by circling the letter of your answer as shown in the example below.

Example:

Multiply $\frac{2}{3}$ by $\frac{3}{4}$.

(A) $\frac{5}{12}$ (B) $\frac{1}{2}$ (C) $\frac{8}{9}$ (D) $\frac{9}{8}$ (E) 2

Sample Answer

A [✓ B] C D E

When you are ready to start the test, tear off this sheet, turn it over, and fill in the information asked for at the top: name, school and date.

Mark only one answer for each question. If you make a mistake, or wish to change an answer, be sure to erase the first answer completely. Your score will be the number of problems you have answered correctly.

DO NOT TEAR OFF THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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Cedar Hall
Stanford University
Stanford, California

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School Mathematics Study Group
A Answer Sheet
Introduction to Algebra
Part I and Part II

Name____________________
School____________________
Teacher____________________
Student Identification No.
A __ __ __ __ __ __

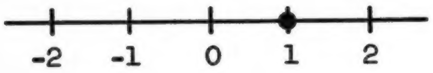
1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. A B C D E
16. A B C D E
17. A B C D E
18. A B C D E
19. A B C D E
20. A B C D E
21. A B C D E
22. A B C D E
23. A B C D E
24. A B C D E
25. A B C D E
26. A B C D E
27. A B C D E
28. A B C D E
29. A B C D E
30. A B C D E
31. A B C D E
32. A B C D E
33. A B C D E
34. A B C D E
35. A B C D E
36. A B C D E

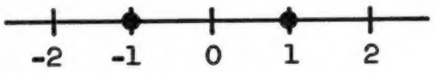
USE THIS SPACE
FOR SCRATCHWORK

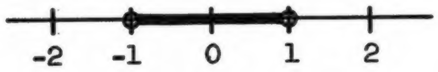
1. If $y < 10$ and $x < y$, then

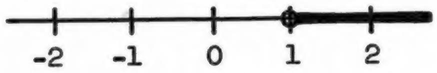
   (A) $x = 10$
   (B) $x < 10$
   (C) $x > 10$
   (D) $x \geq 10$
   (E) x can be any number

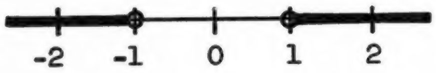
2. Which of the following is the graph of $x^2 - 1 > 0$?

   (A)


   (B)


   (C)


   (D)


   (E)


3. Which of the following is NOT true for every real number x ?

   (A) $x + (-x) = 0$
   (B) $x + 0 = x$
   (C) $x + x = 0$
   (D) $x \cdot 0 = 0$
   (E) $x \cdot 1 = x$

4. Which of the following numbers is irrational?

   (A) $\sqrt[3]{\frac{1}{27}}$
   (B) $\frac{1}{\sqrt{4}}$
   (C) $\frac{4}{9}$
   (D) $\sqrt[3]{8}$
   (E) $\sqrt{8}$

5. The expression $7 - x - (-x - y) + 7$, in simplified form, equals

(A) y (D) $-2x - y$

(B) $y + 7$ (E) $-2x - y + 14$

(C) $y + 14$

6. Assuming r and c are integers, the factors of $27c^2 - 15rc$ are

(A) $27c^2$ and $15rc$

(B) $3c$ and $(9c - 5r)$

(C) $(3c^2 + 5r)$ and $(3 - c)$

(D) 3, $(c^2 + 5r)$, and $(3 - c)$

(E) $3c$, $(9c - 5)$, and r

7. The product of $3a + 1$ and $3a - 4$ is

(A) $9a^2 + 15a - 4$

(B) $9a^2 + 9a - 4$

(C) $9a^2 - 15a - 4$

(D) $9a^2 - 9a - 4$

(E) $9a^2 - 16$

8. The sum of a certain non-zero number and its square is equal to 6 times the number. Find the number.

(A) -6 (D) 5

(B) -5 (E) 6

(C) $\sqrt{6}$

9. Which of the following is non-negative for every value of x ?

(A) $1 - x$
(B) x
(C) $1 - x^2$
(D) $x^2 - 1$
(E) $(1 - x)^2$

10. If $(x - 3)$ is one of two factors of the polynomial $x^2 - 8x + 15$, name the other factor.

(A) $(-x + 5)$
(B) $(-x - 5)$
(C) $(5 + x)$
(D) $(x - 5)$
(E) None of these

11. The graph of $|x - 1| = 4$ consists of the points with coordinates

(A) -5 and 5
(B) -4 and 4
(C) -3 and 3
(D) 3 and 5
(E) -3 and 5

12. For what number n is $43 \times 79 = (43 \times 70) + (43 \times n)$ true ?

(A) 43
(B) 79
(C) 9
(D) 3397
(E) 387

13. The slope of a line which passes through points (-1, 3) and (0, -1) is

(A) 4
(B) $-\frac{1}{4}$
(C) $\frac{2}{3}$
(D) $-\frac{2}{3}$
(E) -4

14. Which of the following polynomials can be factored over the real numbers but NOT over the integers?

(A) $x^2 - 1$
(B) $x^2 - 2$
(C) $x^2 - 4$
(D) $2x^2 - 2$
(E) $4x^2 - 16$

15. Find the prime number p such that 20p is divisible by 6.

(A) 2
(B) 3
(C) 6
(D) 7
(E) 9

16. If $\frac{N}{34} = 22$, then $\frac{N}{17} = (?)$

(A) 11
(B) 22
(C) 44
(D) 748
(E) None of these

17. If n is a positive integer and if a and b are positive and $a^n = b$, then a = (?)

(A) nb
(B) $-\frac{1}{b^n}$
(C) $\frac{1}{\sqrt[n]{b}}$
(D) $\sqrt[n]{b}$
(E) b^n

18. The sentence $\frac{4}{5}x - \frac{5}{3} = \frac{1}{15} - 7x$ is true for what value of x ?

(A) $\frac{6}{109}$ (D) $\frac{6}{11}$

(B) $\frac{2}{9}$ (E) $\frac{1}{5}$

(C) $\frac{4}{15}$

19. If x is a real number, what are all the values of x for which $x^4 + 16$ is a positive number?

(A) All x greater than -2
(B) All x greater than zero
(C) All x greater than 2
(D) All x between -2 and 2
(E) All values of x

20. In the formula $F = \frac{9}{5}C + 32$, if $F = 23$, what is the value of C ?

(A) -5 (D) 47
(B) $-9\frac{2}{9}$ (E) 5
(C) $9\frac{2}{9}$

21. Which of the following is implied by the statement $x > y$?

(A) $x = y + z,\ z > 0$

(B) $x = y + z,\ z < 0$

(C) $|x| > |y|$

(D) $|x| < |y|$

(E) None of these

22. Without multiplying, it is possible to determine that the sentence $(24)(36) = 854$ is false because

(A) $(24)(36)$ is odd, but 854 is even

(B) $(2)(3) \neq 8$

(C) $(4)(6) \neq 54$

(D) 3 is a factor of $(24)(36)$ but 3 is not a factor of 854.

(E) It cannot be determined without multiplying.

23. Each of m couples has 2 children, and each of n other couples has 3 children. How many children do these $m + n$ couples have altogether?

(A) $2m + 3n$

(B) $m + n$

(C) $5(m + n)$

(D) 5

(E) $6mn$

24. If $\sqrt{96} \approx 9.798$ and $\sqrt{9.6} \approx 3.098$, which of the following approximations is incorrect?

(A) $\sqrt{.0096} \approx .09798$

(B) $\sqrt{96000} \approx 309.8$

(C) $\sqrt{960} \approx 30.98$

(D) $\sqrt{.960} \approx .3098$

(E) $\sqrt{9600} \approx 97.98$

25. Given the equation $3x - 6y = 12$, which of the following is the correct description of the graph of this equation?

(A) The slope is 2 and the y-intercept is -2.

(B) The slope is 3 and the y-intercept is 12.

(C) The slope is $\frac{1}{2}$ and the y-intercept is 4.

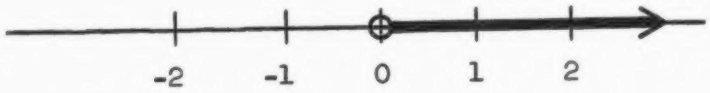
(D) The slope is $-\frac{1}{2}$ and the y-intercept is 2.

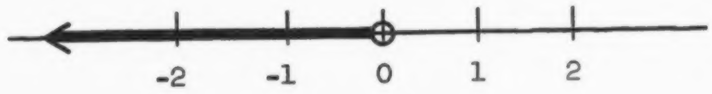
(E) The slope is $\frac{1}{2}$ and the y-intercept is -2.

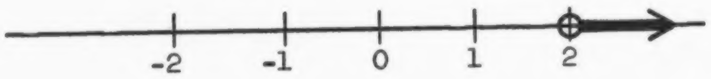
26. If $\frac{a - 1}{a + 1}$ and its reciprocal are both real numbers, what real numbers must be excluded from the domain of a ?

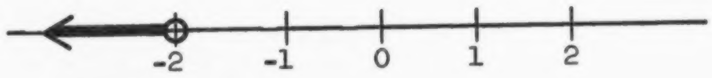
(A) 1 only
(B) -1 only
(C) 0 only
(D) 1 and -1 only
(E) 1, -1, 0 only

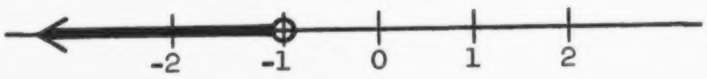
27. Which of the following is a graph of $3x > 5x$?

(A)


(B)


(C)


(D)


(E)


28. If the reciprocal of u is v and the reciprocal of v is w, then w is

(A) $\frac{1}{u^2}$
(B) $\frac{1}{u}$
(C) u
(D) 1
(E) u^2

29. If a is positive and b is negative and $|a| < |b|$, then $a + b$ is

(A)	one	(D)	negative
(B)	positive	(E)	not defined
(C)	zero		

30. One solution of the equation $x^2 - 151,321 = 0$ is 389. Another solution is

(A) 150,932
(B) -389
(C) 0
(D) 519
(E) 151,710

31. Which one of the following numbers is a better approximation than the others to the root of the equation?

$$1.33x - 9.89 = 0.34x$$

(A) 0.1
(B) 1
(C) 5
(D) 10
(E) 100

32. $\frac{x - 3}{x + 3}$ divided by $\frac{x + 3}{x^2 - 9}$ equals

(Assume: $x \neq 3$ and $x \neq -3$.)

(A)	$\frac{(x - 3)^2}{x + 3}$	(D)	$\frac{x + 3}{(x - 3)^2}$
(B)	$\frac{1}{x + 3}$	(E)	$x + 3$
(C)	$x - 3$		

33. If $x < 0$, $\sqrt{x^2} = (?)$

(A) $-x^2$

(B) $-x$

(C) $-|x|$

(D) 0

(E) x

34. If the equations $6x + 3y = 17$ and $4x + y = 7$ are solved simultaneously, $x + y = (?)$

(A) $\frac{7}{4}$

(B) 5

(C) $\frac{17}{3}$

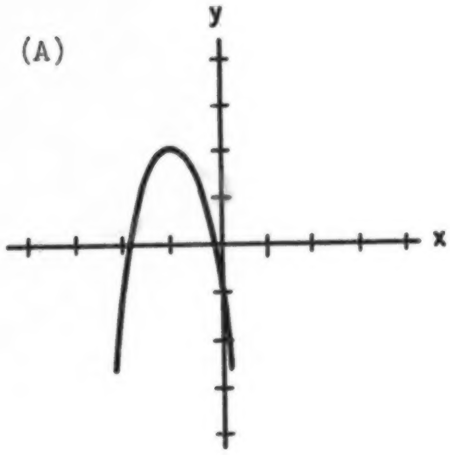
(D) 10

(E) 24

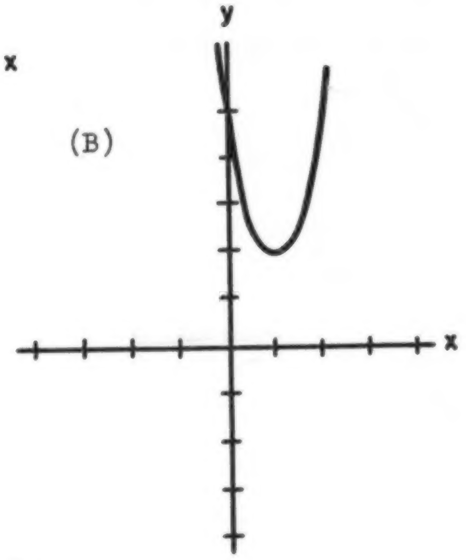
35. Which of the following graphs is the graph of the equation

$y = -3(x - 1)^2 + 2$?

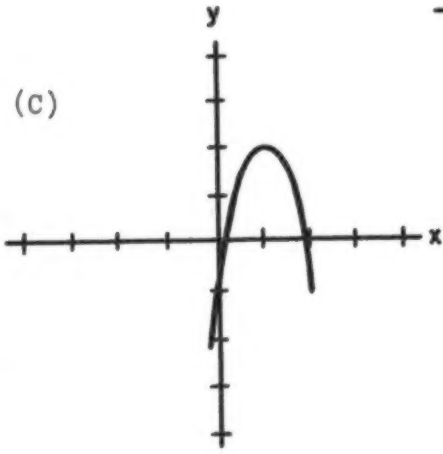
(A)



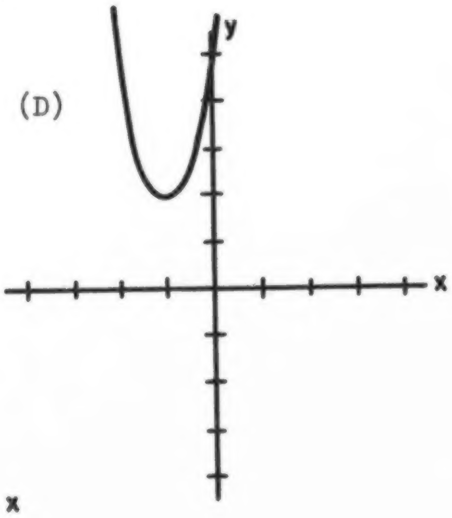
(B)



(C)



(D)



(E)